UNIVERSITY OF MOHAMMED KHIDER- BISKRA
DEPARTEMENT OF NATURAL AND LIFE SCIENCES

ECOLOGIE GÉNÉRALE

GENERAL ECOLOGY

PROGRAM

Chapter I General Information on Ecology

- Definition of the ecosystem and its constituents (Concepts of biocenosis and ecological factor.)
- Domains of intervention

Chapter II Environmental factors

- Abiotic factors
  - climatic
  - Edaphic
  - Hydric
- Biotic factors
  - Hydric

PROGRAM

- Competitions
- Pests and Predators
- Cooperation and symbiosis
- Parasitism
- Interaction of environments and living beings
- Role of ecological factors in population regulation
- Concept of ecological optimum
- Ecological valence
- Ecological niche

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- Consumers, producers, and decomposers

Chapter IV — Ecosystem Function

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PROGRAM

Chapter V Brief description of the main ecosystems

- Forest, grassland, surface waters, ocean
- Evolution of ecosystems and the concept of climax

Chapter I

General Information on Ecology

Definitions

- The word ECOLOGY was invented in the 19th century (*1866*) by a German biologist named *Ernst Haeckel*.

- The word ecology is of Greek origin and can be divided into: *oikos* meaning the house or living environment, and *logos* meaning science.

Definitions

- *Ecology* is the science that studies the conditions of existence of living beings and the interactions of all kinds that exist between these living beings, on the one hand, and between these living beings and their environment, on the other hand.

Definitions

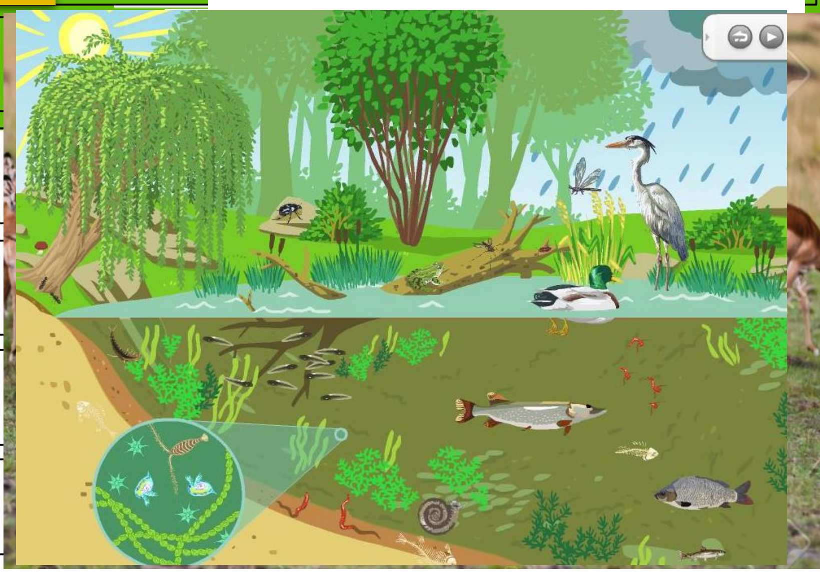
- *Ecology* is based on related sciences such asclimatology, hydrology, oceanography, chemistry, geology, pedology, physiology, genetics, and ethology, ... Which makes ecology a multidisciplinary science.

Main levels of integration of biological materials

Hierarchy of the living

ECOLOGY

Ecosystem	Ecosystemology
Community	Synecology
Population	
Individual	
Organ	
Tissue	
Cell	
Molecule	



Domains of intervention

- Les études écologiques portent conventionnellement sur trois niveaux : *L'individu*, *la population* et *la communauté*.

An *individual* (organism) is a specimen of a given species.

A *population* is a group of individuals of the same species occupying a particular territory at a given period.

A *community* or *biocenosis* is the set of populations of the same environment, animal population (zoocenosis) and plant population (phytocenosis) which live in the same environmental conditions and in the neighboring of each other

Domains of intervention

➢ Each of these three levels is the subject in ecology

the individual concerns *autoecology*: it is the science that studies the relationships of a single species with its environment. It defines the limits of tolerances and the preferences of the species studied with respect to the various ecological factors and examines the action of the environment on morphology, physiology and ethology.

population concerns *population ecology* or *population dynamics* or *demecology* : it is the science that studies the qualitative and quantitative characteristics of populations.

Domains of intervention

Biocenosis concerns *synecology*: a branch of ecology that deals with the structure, development, and distribution of ecological communities.

Ecosystem concept

Ecosystem

Biocenosis = Zoocenosis + Phytocenosis

Biotope

Ecosystem concept

Ecosystem

The concept of ecosystem was defined by the English botanist *Arthur Tansley* in *1935*. An *ecosystem* is by definition a system, that is to say a set of elements in interaction with each other. It is a biological system formed by two inseparable elements, the **biocenosis** and the *biotope*.

biocenosis

is the set of organisms that live together (zoocenosis, phyocenosis, microbiocenosis, mycocenosis, etc.).

biotope

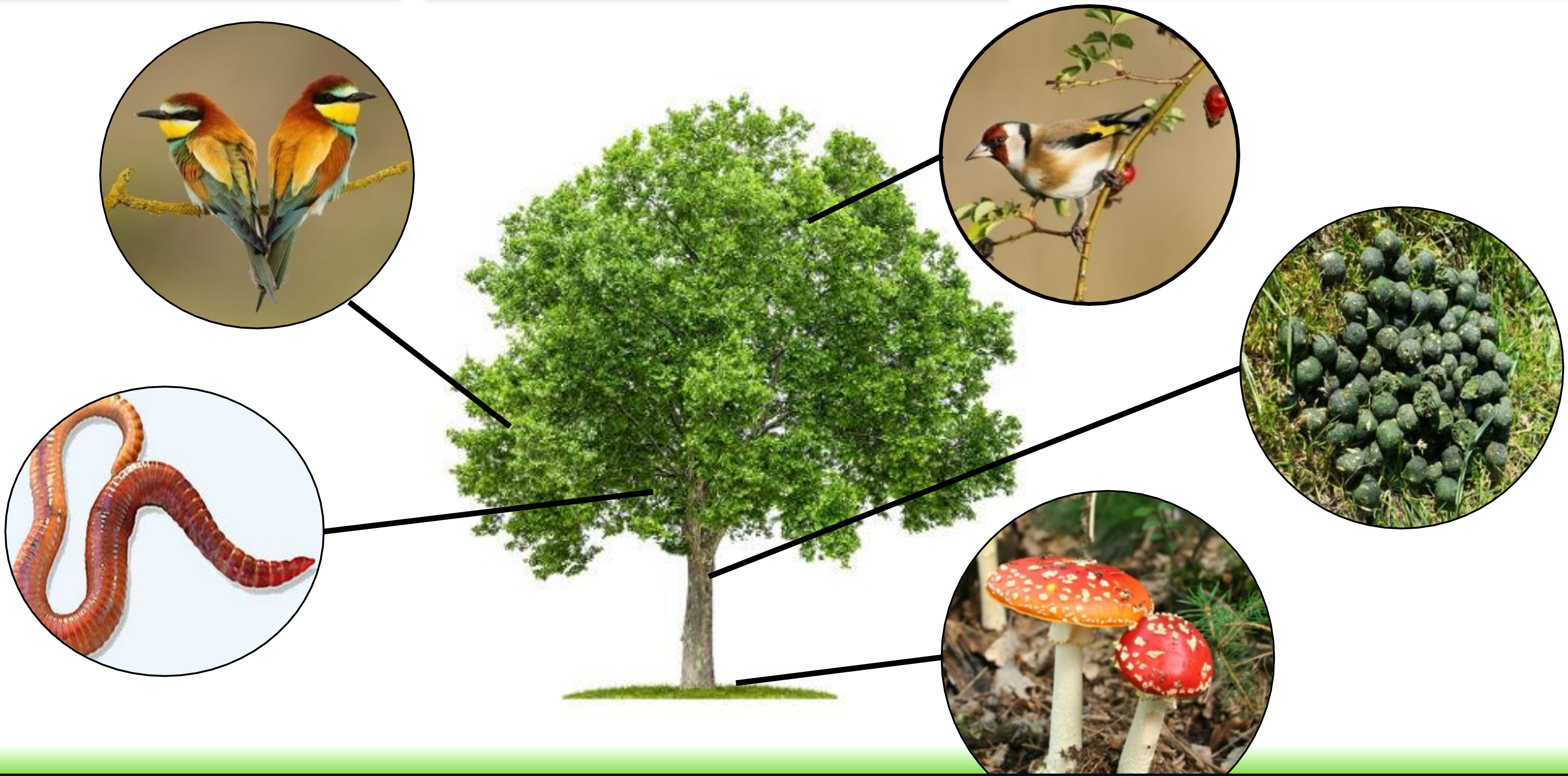
is the fragment of the biosphere which provides the biocenosis with the essential abiotic environment.

Ecosystem It is the basic *functional unit* in ecology established by a set of elements in perpetual interactions forming a coherent and ordered set.

Ecosystem classification

Ecosystems are classified according to their extent

micro-ecosystem | **meso-ecosystem** | **macro-ecosystem**



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Ecosystem classification

Ecosystems are frequently classified in to *three classes* referring reference to biotopes:

- *Continental (terrestrial) ecosystems*: *forest* ecosystems (forests), *grassland* ecosystems (grass, steppes, savannas), *agro-ecosystems* (agricultural systems).

- *Continental water ecosystems*: *lentic* ecosystems (lakes, ponds) or *lotic* ecosystems (rivers, streams)

- *Marine or oceanic ecosystems*: (seas and oceans)

Ecosystem classification

Continental ecosystems

Ecosystem classification

Continental water ecosystems

Ecosystem classification

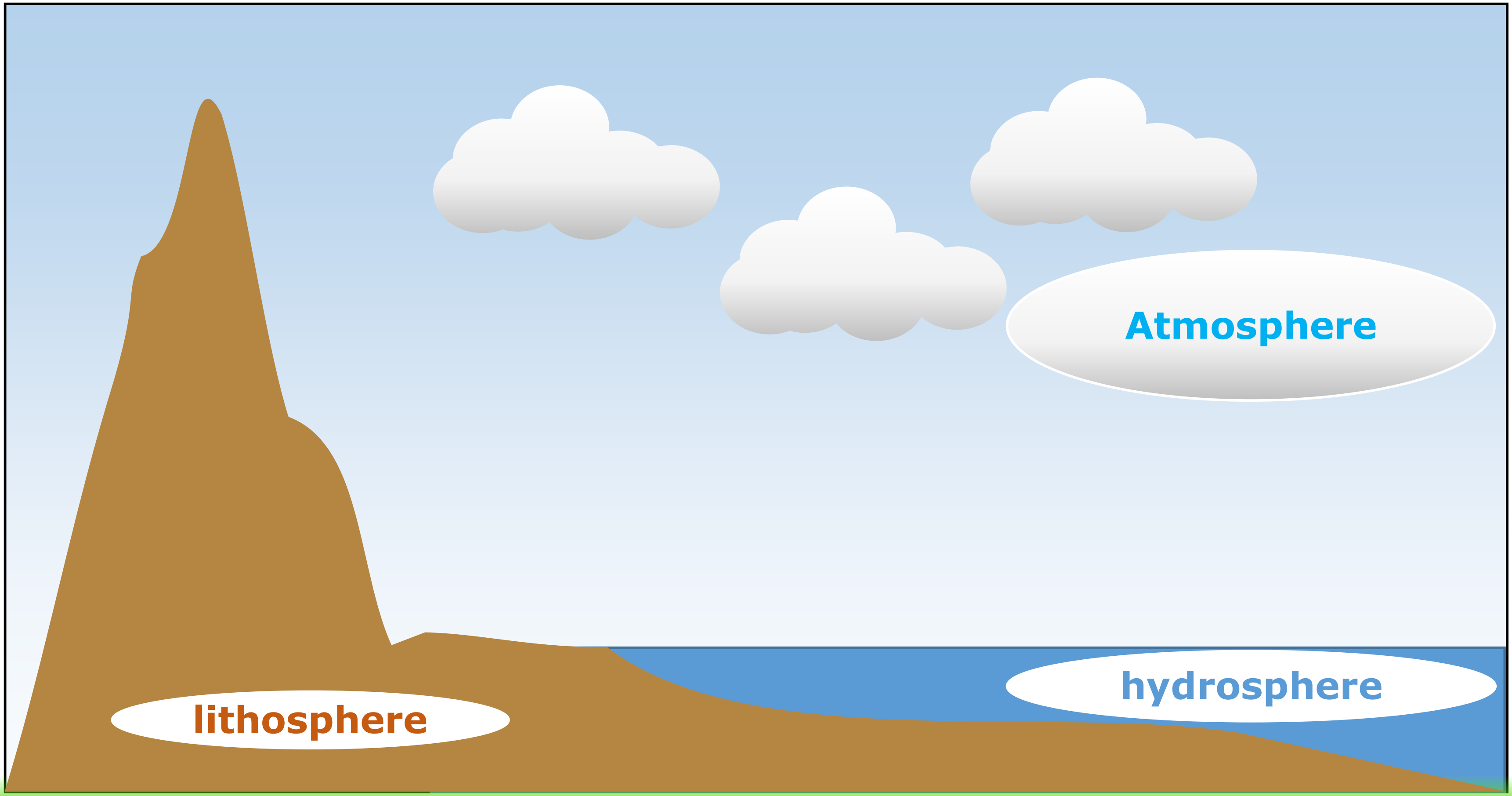
oceanic ecosystems

Biosphere

The *biosphere* is the part of the Earth's crust where life is possible.

Biosphere

The *biosphere* includes three regions of different physical nature



Biosphere

The *Biosphere* includes apart of the *lithosphere* (solid part of the Earth's crust), a part of the *atmosphere* (the gaseous layer surrounding the Earth) and a part of the *hydrosphere* (part of the Earth's system made up of water).

The **biosphere** is characterized by: (1)existence of contact zones (exchanges and recycling); (2) presence of liquid water in sufficient quantity; (3) the sun represents major energy source; (4) complex system(great biodiversity); (5) irregular mosaic structure (oceans, continents).

Chapter II

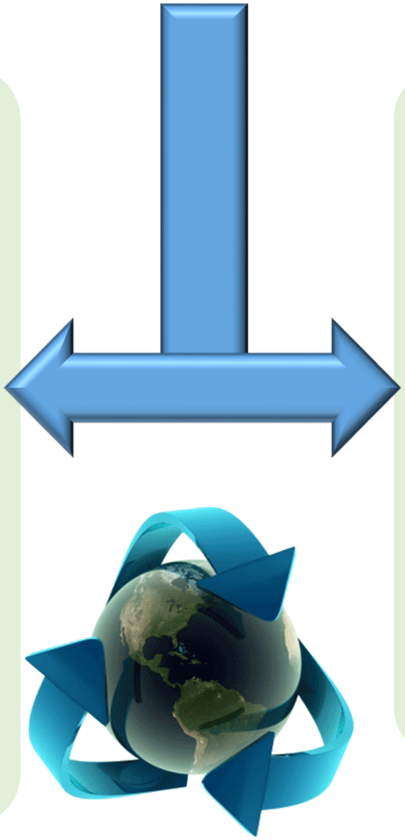
Environmental factors

Environmental factors

An "*ecological factor*" is any element of the environment that can act directly on living beings. There are two types of ecological factors:

Abiotic factors

Set of physicochemical characteristics of the environment such as climatic factors (temperature, rainfall, light, wind, etc.), edaphic factors (texture and structure of the soil, chemical composition, etc.)



Biotic factors

set of interactions that exist between individuals of the same species or different species: predation, parasitism, competition, symbiosis, commensalism, etc.

Interaction between the environment and living beings

The reactions of living beings to variations in the physicochemical factors of the environment affect morphology, physiology and behavior.

Living beings are completely eliminated or their numbers are greatly reduced when the intensity of ecological factors is close to or exceeds tolerance limits.

- **A** Tolerance law (tolerance interval)
- **B** Law of minimum
- **C** Limiting factor

Interaction between the environment and living beings

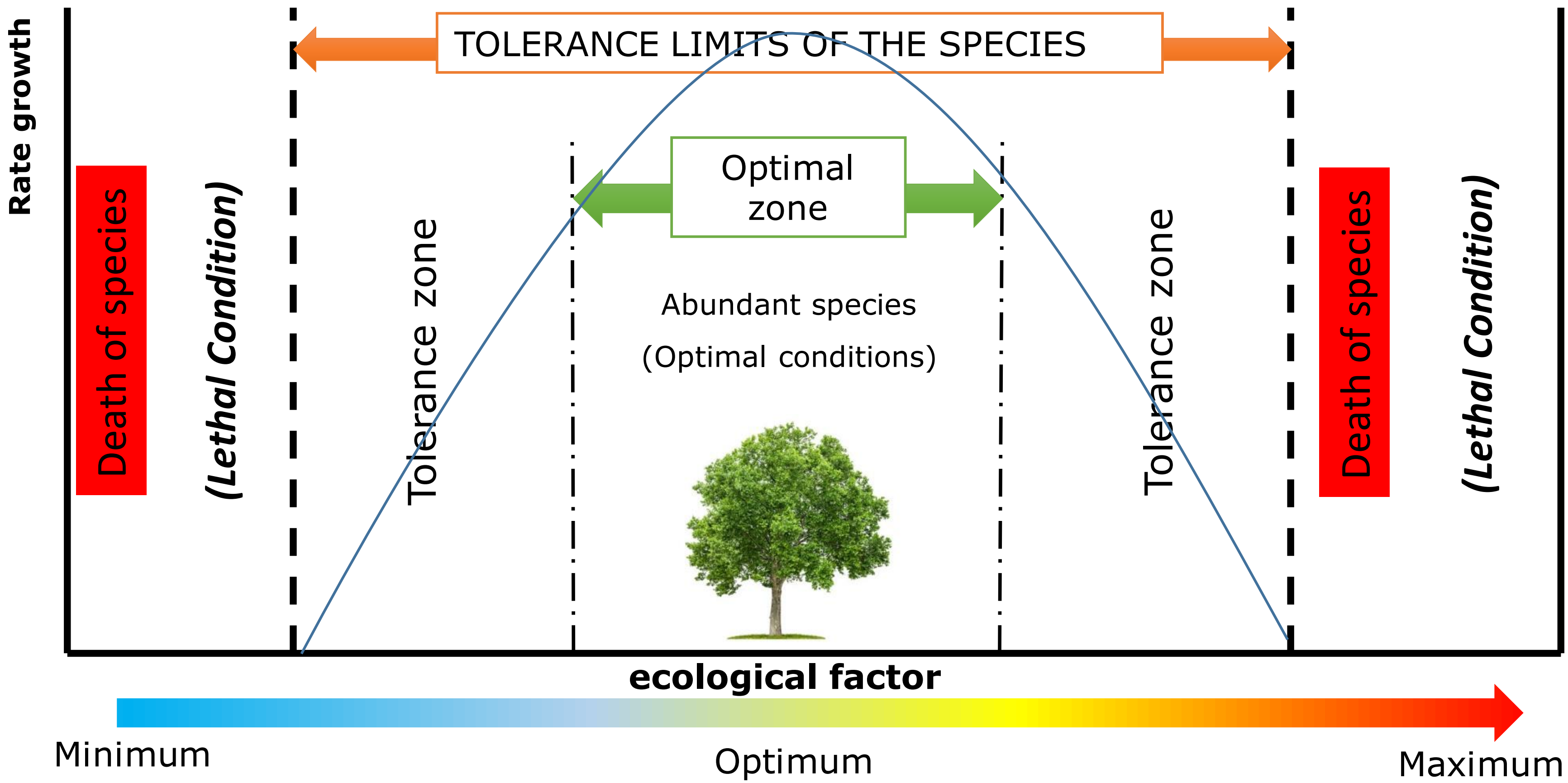
A Tolerance law (tolerance interval)

Stated by *Shelford in 1911*, the *law of tolerance* states that for any environmental factor there is a range of values (or *tolerance interval*) in which any ecological process dependent on that factor can be done normally.

It is only within this interval that the life of a particular organism, population or biocenosis is possible. The lower limit along this gradient delimits death by deficiency, the upper limit delimits death by toxicity. Within the *tolerance interval*, there is an *optimal value*, called the "*ecological optimum*“, where the metabolism of the species or community reached a maximum speed.

Interaction between the environment and living beings

A Tolerance law (tolerance interval)



Interaction between the environment and living beings

A Tolerance law (tolerance interval)

The *ecological valence* of a species represents its capacity to support ± variations in an ecological factor. It represents the capacity to colonize or populate a given biotope.

A species with high ecological valence, that is to say able to populate very different environments and support significant variations in the intensity of ecological factors, is called **euryecious**.

A species with low ecological valence will only be able to support limited variations in ecological factors, it is called **stenoecy**.

A species with an average ecological valence is called **mesoeceous.**

Interaction between the environment and living beings

B Law of minimum

Law of the minimum or *Liebig's law (1840)* "Every ecological process is conditioned by the factor which is the weakest represented in the environment". Ex: Plant requirements for mineral elements.

The law of the minimum states that the growth of a living being is possible if the essential elements are present in sufficient quantities in the environment.

Liebig's law is generalized to all ecological factors in the form of a law called the "*law of limiting factors*".

Interaction between the environment and living beings

C Limiting factor

An *ecological factor* acts as a *limiting factor* when it is absent or reduced below a critical threshold or if it exceeds the maximum tolerable level.

Ecological niche

The term *ecological niche*, created by *Grinellin 1917*. The ecological niche can be defined in the simplest way as the place and specialization of a species within a population. It corresponds to the set of parameters which characterize the ecological requirements (*climatic, food, reproductive, etc.*) specific to a living species and which differentiate it from neighboring species in the same population.

Ecological niche

Organisms can change niches as they develop. Ex: *Tadpoles* occupy an aquatic environment (feeding on algae and detritus) before metamorphosing into adults (*frogs*), where they become amphibians (feeding on insects).

Ecological niche

Abiotic factors

Physicochemical factors of the environment such as temperature, light, water, nutrients (chemical elements essential for plant growth: nitrates, phosphates)...

Climatic fact

- Temperature
- Humidity and r
- Lumière et ensc
- Wind
- Snow

Edaphic factors

- Soil texture
- ;oil structure
- Water soil
- chemical factors

Climate factors

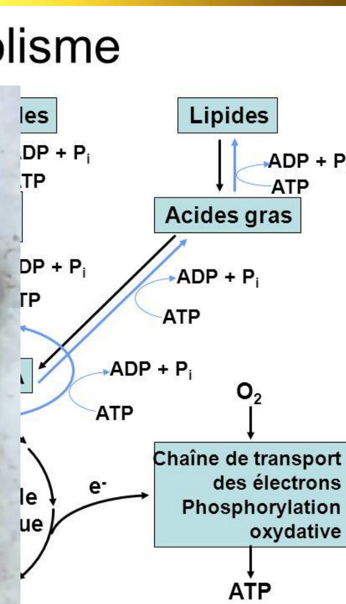
Climate is the set of atmospheric and meteorological conditions specific to a region of the globe. The climate of a region is determined from the study of meteorological parameters (temperature, humidity level, precipitation, wind strength and direction, duration of sunshine, etc.) evaluated over several decades.

Main climatic factors

There are many elements of the climate that play an ecological role. The *main ones* are *temperature*, *humidity and rainfall, illumination and photoperiod* (distribution, during the day, between the duration of the diurnal phase and the nocturnal phase). Others, such as *wind* and *snow*, are *less important*, but in some cases they can play a significant role.

Temperature

Temperature is the most import since depen photos digesti which a rea tempe

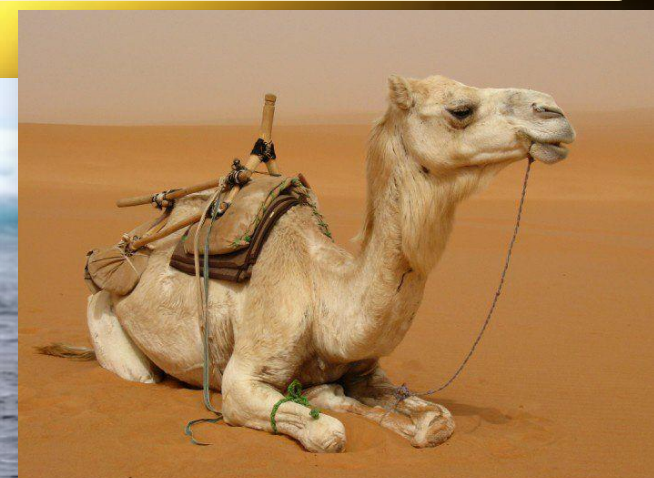


The m mperature range between 0 and 50°C on average. Temperatures too low or too high trigger a dormant state in some animals called *aestivation* or *hibernation*. In both cases, development is almost stopped.

Main climatic factors

Temperature

The limits of geographic distribution are often determined by temperature which acts as a limiting factor. Specially, it is extreme temperatures that limit the colonization of a species in an environment.



Main climatic factors

Humidity and pluviosity

Water represents 70 to 90% of the tissues of many species in an active state . Water supply and loss reduction are fundamental ecological and physiological problems.

Based on their water needs, and consequently their distribution in the environments, we distinguish:

Main climatic factors

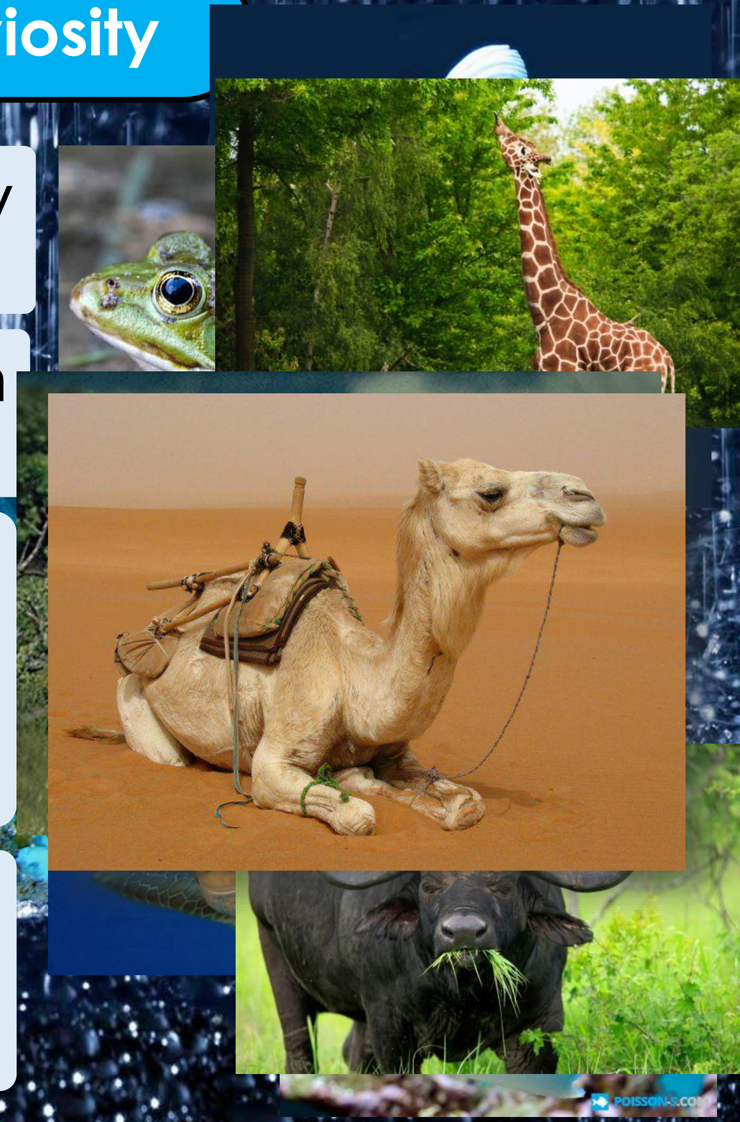
Humidity and pluviosity

Aquatic species that live permanently in water.

Hygrophilous species that live in humid environments.

Mesophilic species with moderate water requirements and which tolerate alternations of dry and wet seasons.

Xerophilous species that live in dry environments where water deficit is accentuated.



Main climatic factors

Living beings adapt to drought in very different ways

In plants

Reduction of *evapotranspiration* by development of impermeable *cuticular* structures.

Reduced number of *stomata*.

Reduction in the surface area of leaves which are transformed into *scales* or *thorns*.

The leaves *fall* in the dry season and reform after each rain.

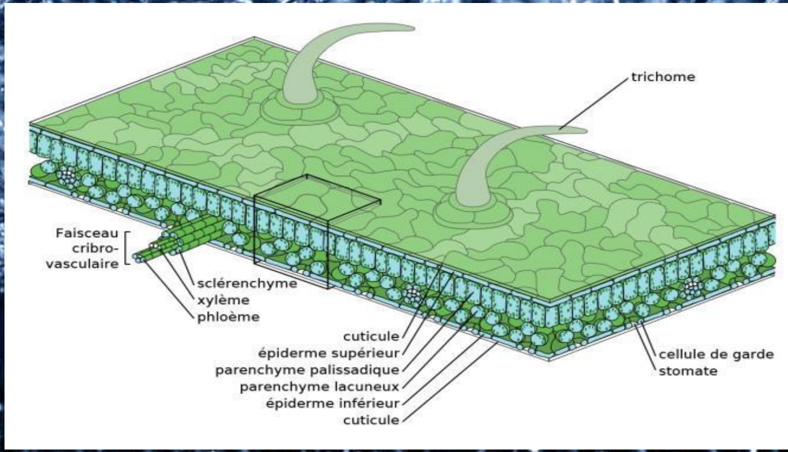
Main climatic factors

Living beings adapt to drought in very different ways

In plants

The plant ensures its water supply by a powerful underground roots.

Storage of water in aquifer tissues associated with good epidermal protection.



Main climatic factors

Living beings adapt to drought in very different ways

In animals

Use of water from food.

Reduction in the excretion of water by emission of increasingly concentrated urine.

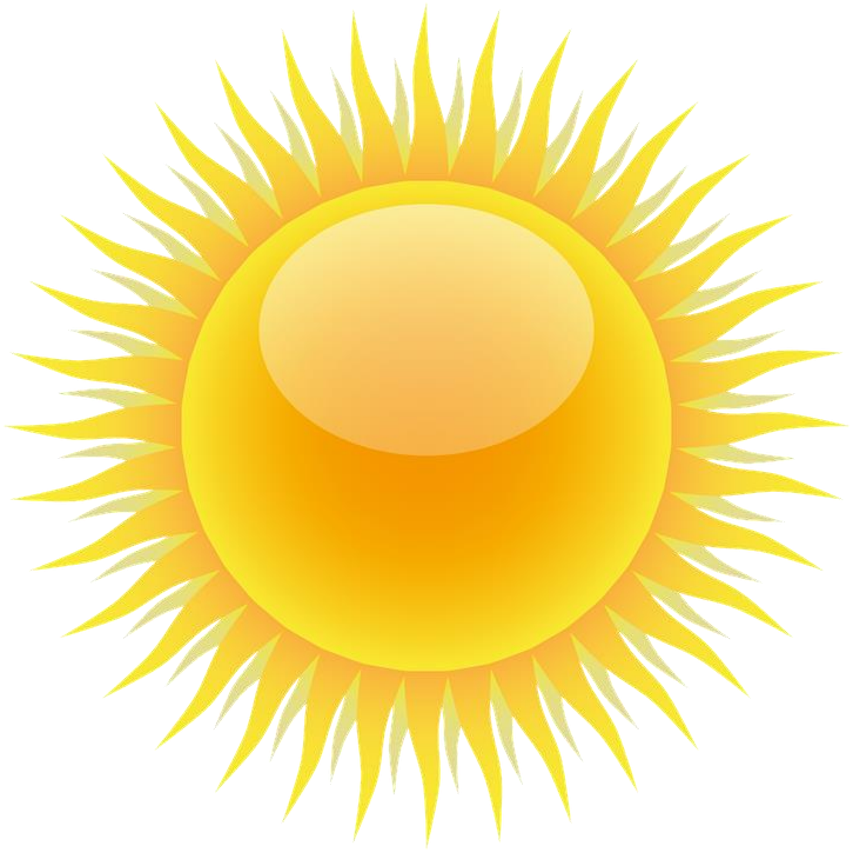
Use of *metabolic water* from by the oxidation of fats (Camel).

Main climatic factors

Light and sunshine

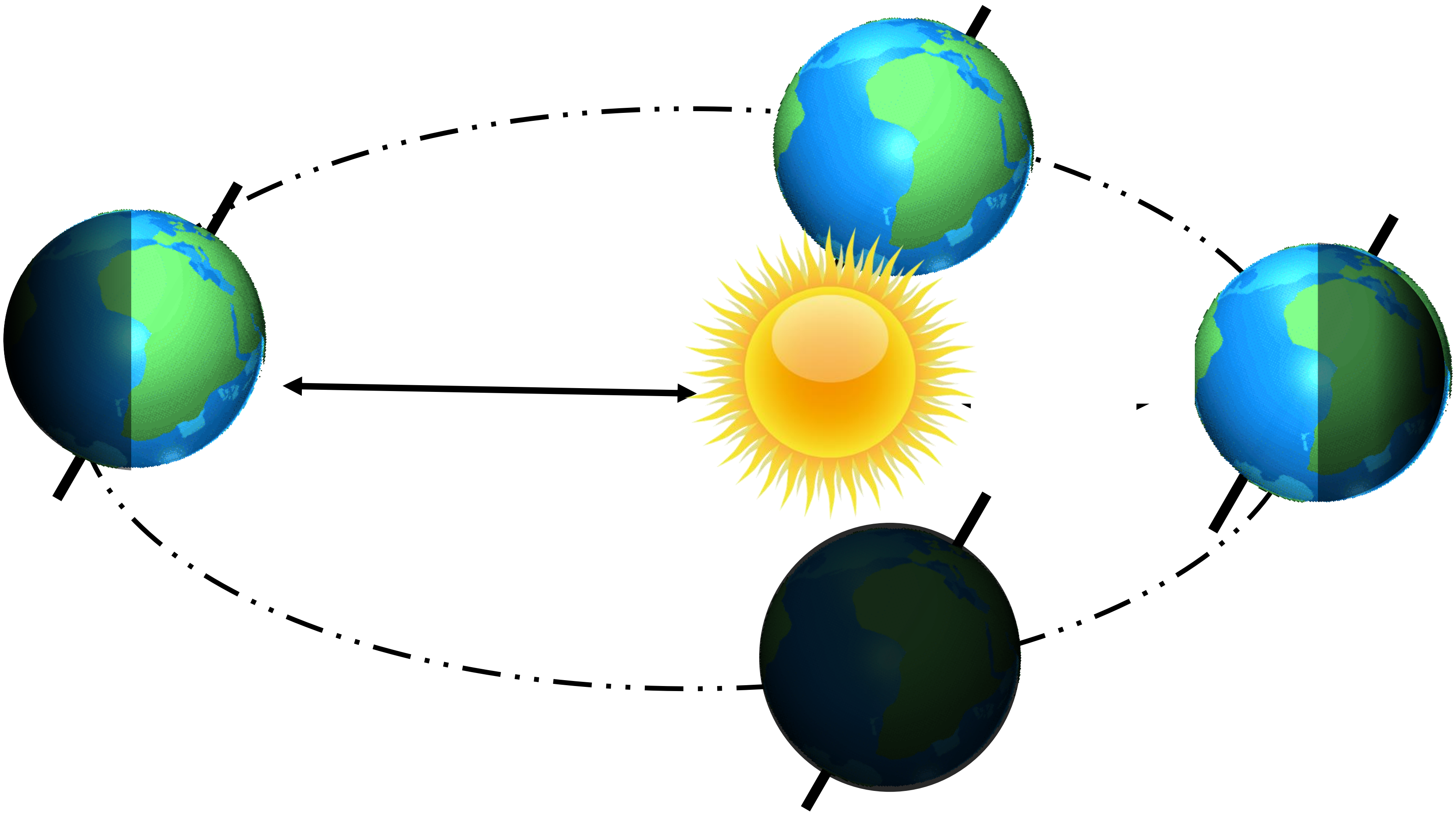
Sunshine is defined as the Duration time of sun shining. Solar radiation is composed mainly of *visible light*, *infrared rays* and *ultraviolet rays*.

Illumination has an important effect not only through its intensity and nature (*wavelength*) but also through the duration of its action (*photoperiod*).



Main climatic factors

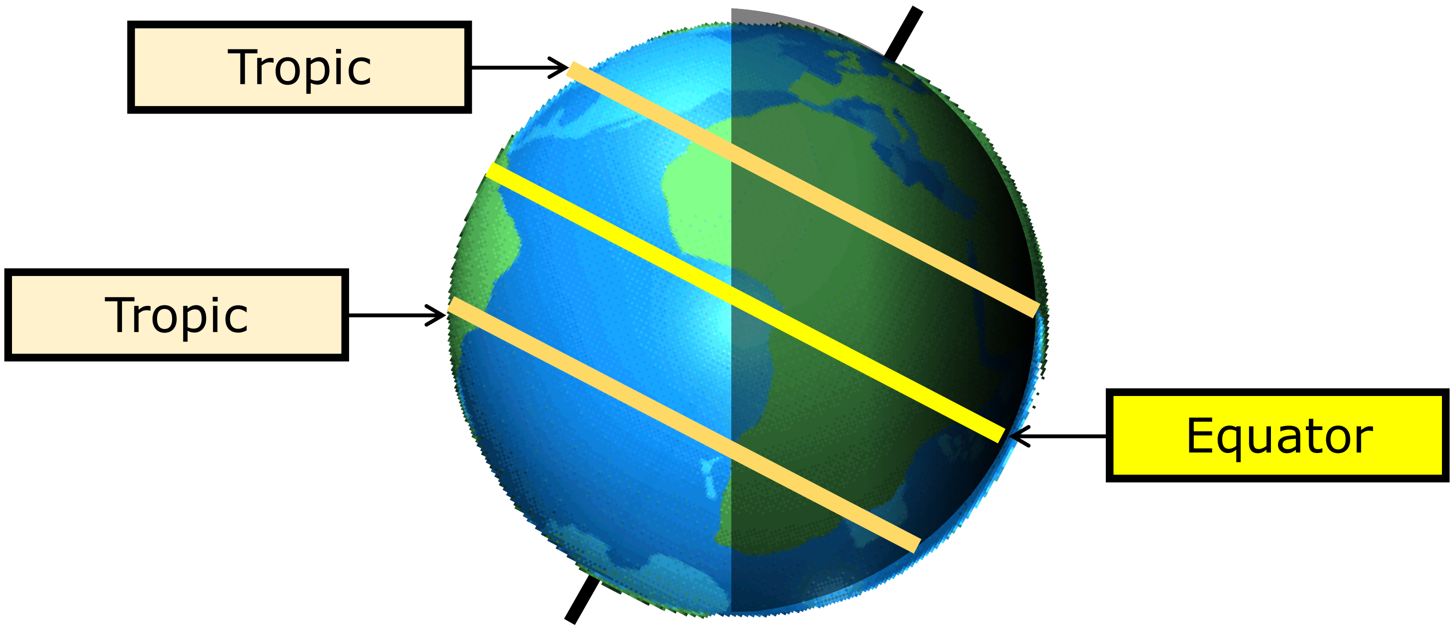
Light and sunshine



Main climatic factors

Light and sunshine

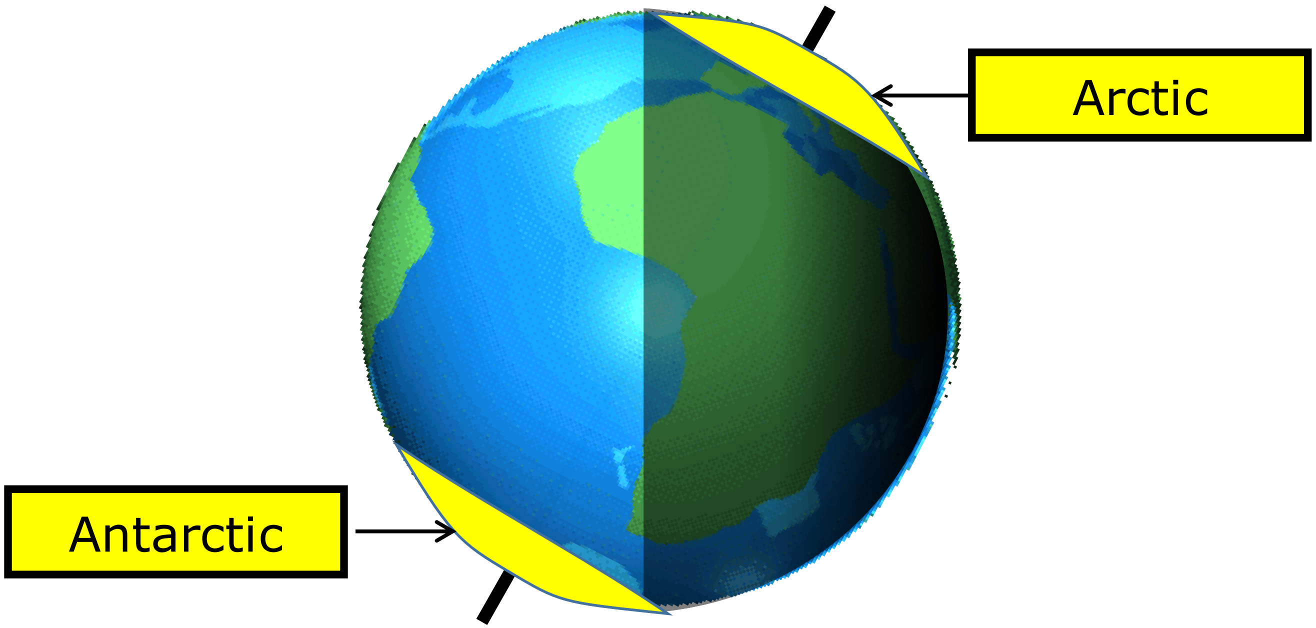
The *photoperiod* increases from the Equator towards the Poles. the Equator, the days are strictly equal to the nights, throughout the year. In the Tropics, the inequality remains low and practically without influence.



Main climatic factors

Light and sunshine

At very high *latitudes*, that is to say beyond the *polar circle*, nights and days exceed 24 hours, reaching 6 months of days and 6 months of night at the Poles themselves.



Main climatic factors

Light and sunshine

The atmosphere plays the role of a screen or better a filter by stopping certain radiations and allowing others to pass through. In fact, the atmosphere *absorbs* part of the solar radiation, and *diffuses* another portion. In addition to these two actions, there is a phenomenon of *reflection*.

Main climatic factors

Plants are adapted to the *intensity* and *duration of light*. This adaptation is important when plants move from the *vegetative stage* (*growth and development phase*) to the reproductive stage (*flowering*).

Plants can be divided into three categories

1 Short-day plants (nyctiperiodic)

Flowering only if the photoperiod at the time of *bud burst* is *less than or equal to 12 hours* of light.

2 Long-day plants (hemeroperiodic)

which need at *least 12 hours* of light to flower.

3 The indifferent (photoaperiodic)

light duration plays *no role* in flowering.

Main climatic factors

Effects on animals

In animals, the essential role of photoperiod lies in the maintenance of *seasonal biological rhythms*, and *daily* (*circadian*)

1 seasonal biological rhythms — there are two types

Reproduction rhythm in vertebrates

reproduction period coinciding with the favourable season.

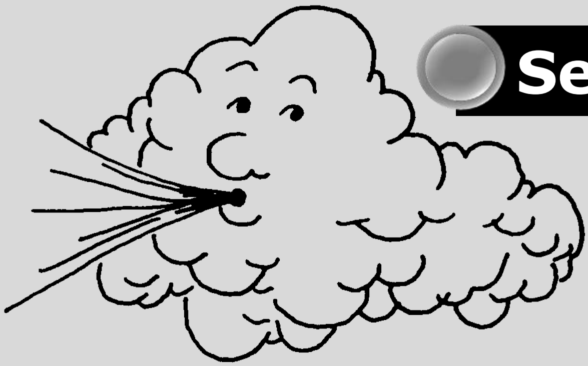
Diapause

Photoperiod is the essential factor that triggers the animal to enter diapause before the *unfavorable season* arrives.

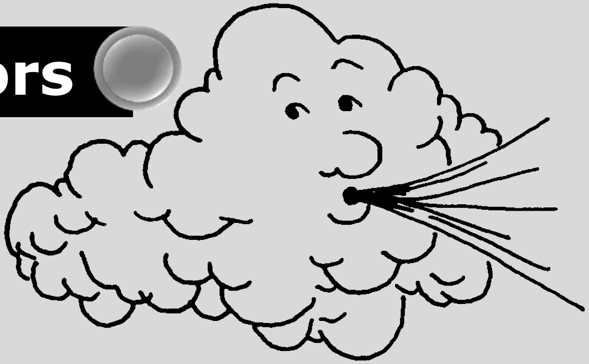
Main climatic factors

2 Daily or circadian rhythms (nycthemeral)

These are rhythms with a period equal to 24 hours. They are maintained by a *poorly understood internal mechanism* called a "*biological clock*", the adjustment of which is conditioned by *lighting and temperature*.

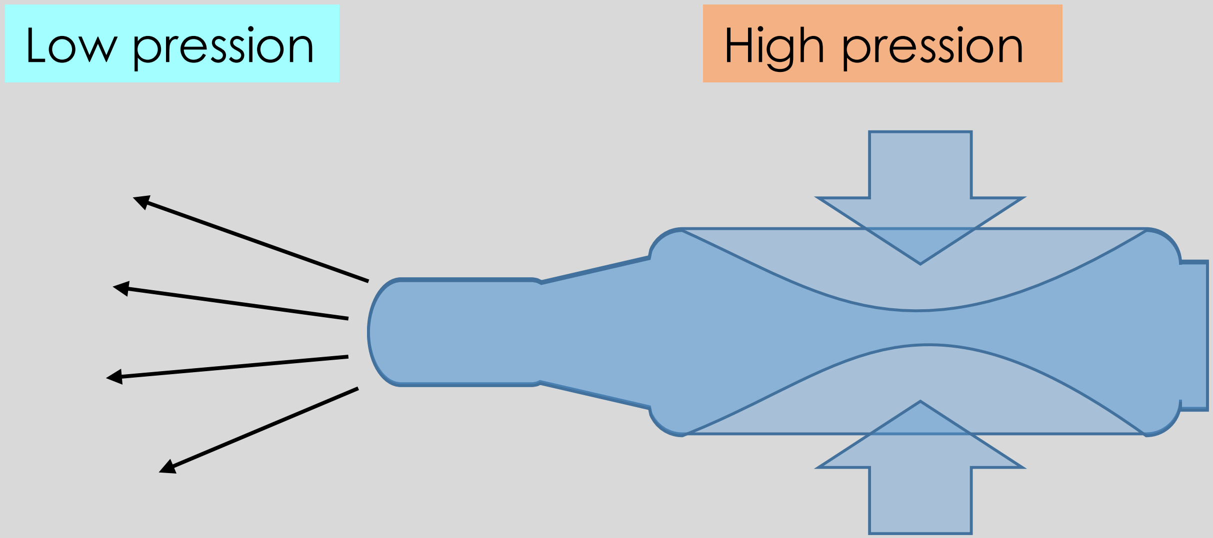


Secondary climatic factors



Wind

Wind results from the movement of the atmosphere between high and low *pressures.*



Secondary climatic factors

Wind

The impact of this factor on living beings can be summarized as follows:

- It has a drying power as it increases evaporation.
- It also has considerable cooling power.
- The wind is an agent of animal and plant dispersal.
- Insect activity is slowed by the wind.

Depending on the preference of living beings for *wind speed*, we distinguish:

Aerophilous species (*anemophily*): refers to a species dependent on biotopes exposed to strong winds.

Aerophobious species (*Anemophily*): refers to a species restricted to non-windy habitats.

Secondary climatic factors

Wind

Depending on the preference of living beings for *wind speed*, we distinguish

Aerophilous species (anemophily):

refers to a species dependent on biotopes exposed to strong winds.

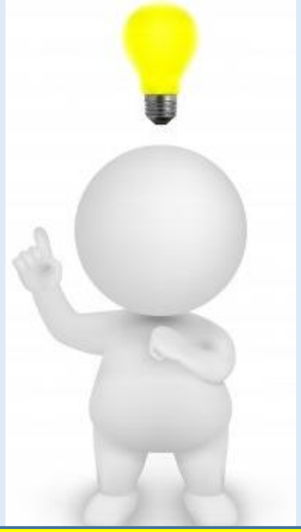
Aerophobious species (*Anemophily*)

refers to a species restricted to non-windy habitats.

Secondary climatic factors

Snow

It is an important ecological factor in the mountains.



The snow cover protects the ground from cooling.

Example

Edaphic factor

Soil definition

Soil is a *complex* and *dynamic* living environment, defined as the natural surface formation, *movable structure* and *varying thickness*, esulting from the transformation of the the *mother rock* under the influence of various processes: *physical*, *chemical* and *biological*, in contact with the atmosphere and living beings.

Edaphic factor

Soil texture

The soil texture is defined by the size of the particles that compose it: gravel, sand, silt, and clay.

Edaphic factor

granulometry

measurement of the *shape*, *size* and *distribution* of grains and particles into different classes.

2 mm	<	**Gravel**		
0,2 mm	<	**Coarse sands**	<	2 mm
20 µm	<	**Fine sands**	<	0,2 mm
2µm	<	**Silt**	<	20 µm
		Clay	<	2µm

1 mm = 1000 µm

Edaphic factors

Depending on the *proportion* of these *different particle size* fractions, we determine the following textures

Fine textures: contain a *high clay content (>40%)* and correspond to so-called "*heavy soils*", difficult to work, but which have *optimum water retention*.

Sandy or coarse textures: these characterize light soils *without cohesion* and which *drying out seasonally*.

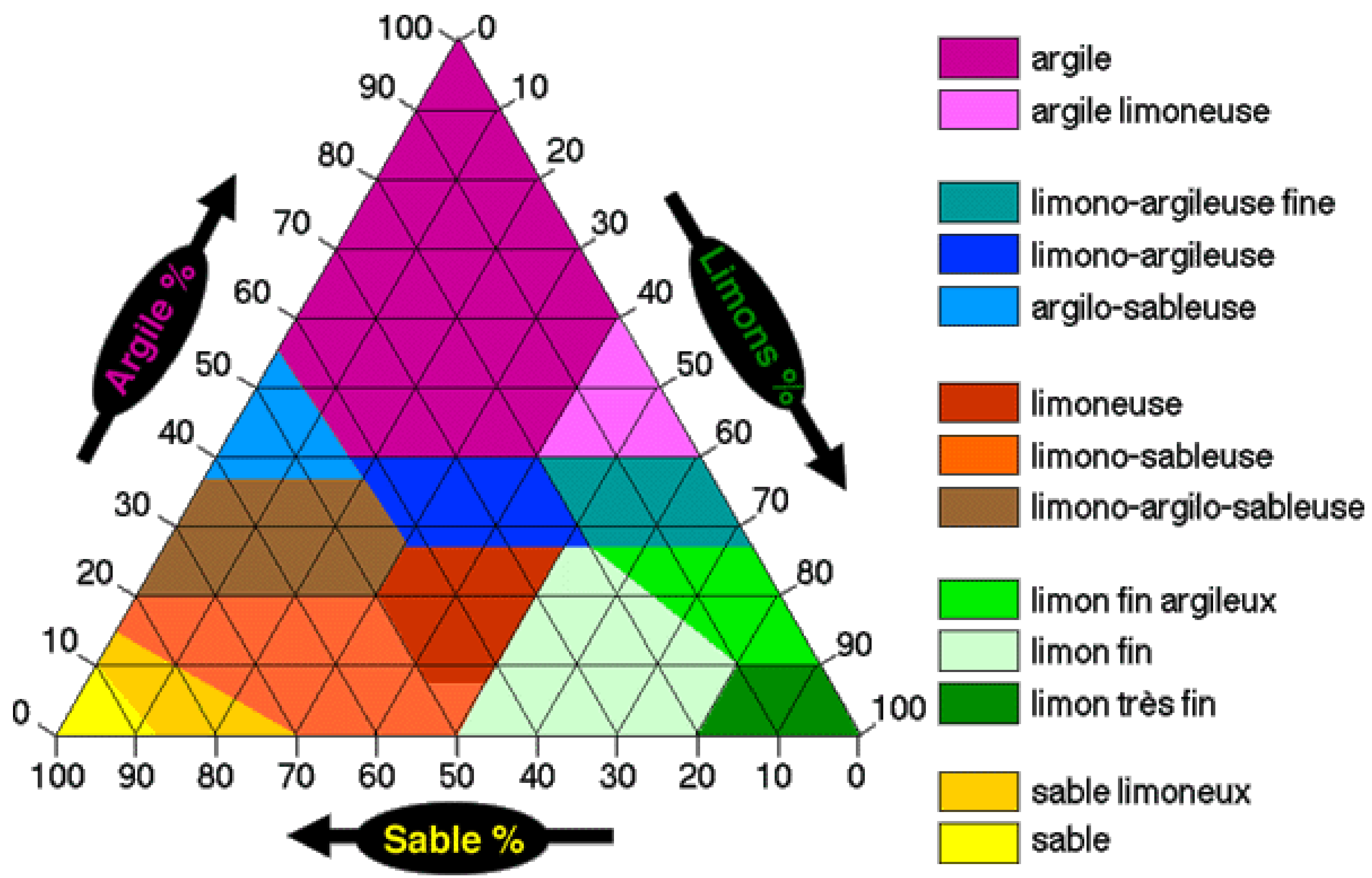
Medium textures: we distinguish two types:

*Sandy-clay-loam*s that contain between *30 to 35% of silt*, which have a *perfectly equilibrium texture*.

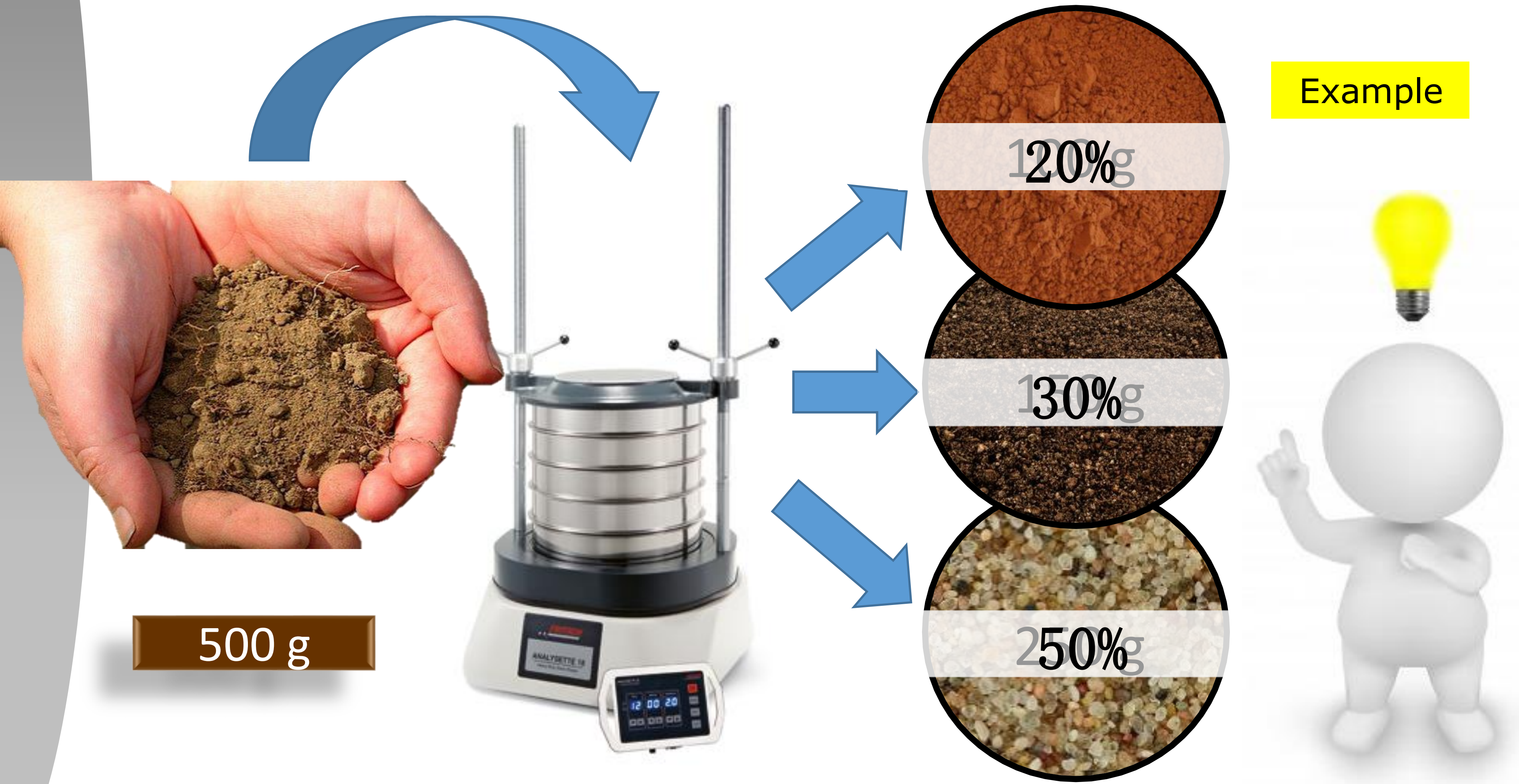
Silty soils, which contain *more than 35% silt*, are poor in humus (soil organic matter resulting from the partial decomposition of animal and plant matter).

Edaphic factors

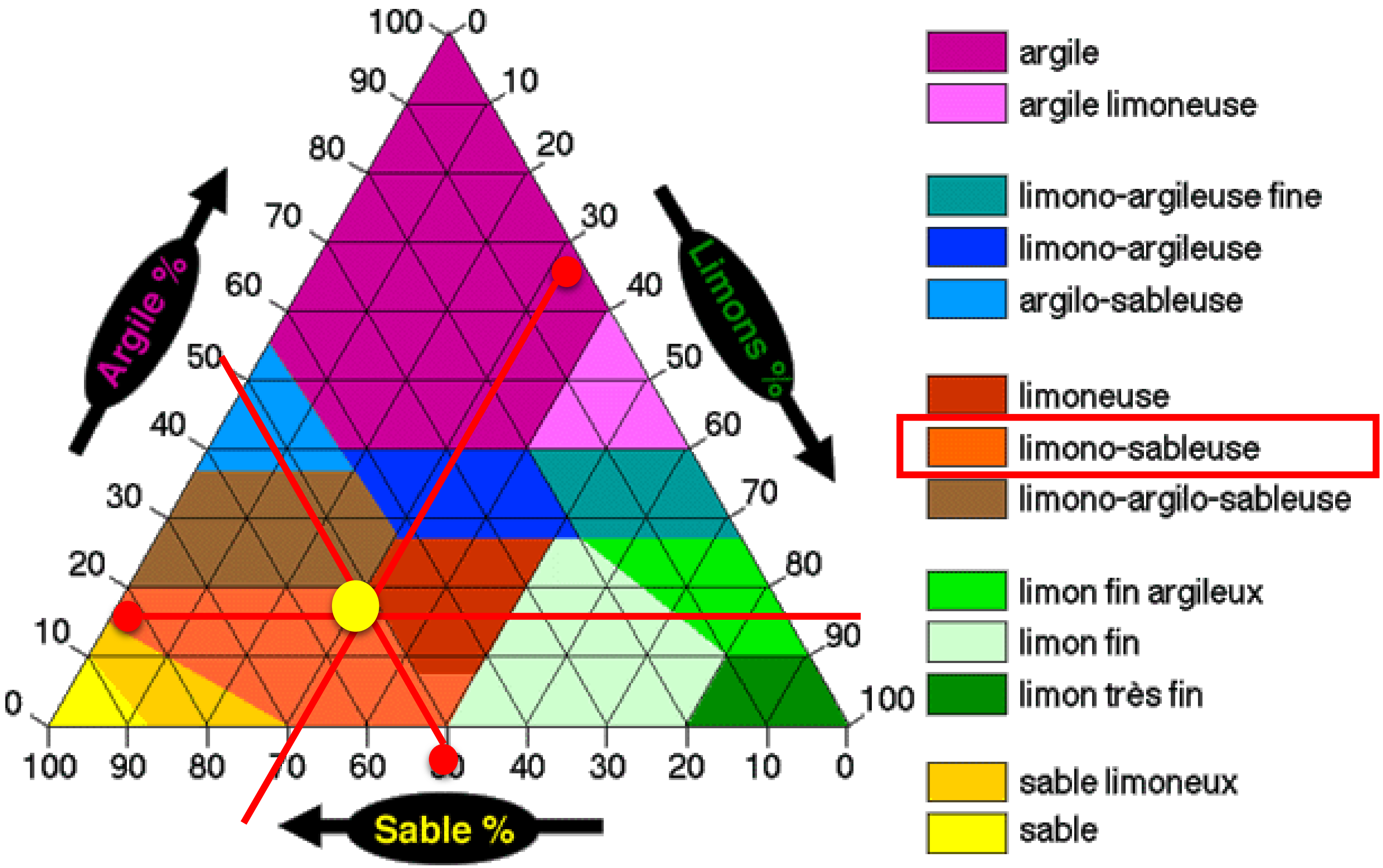
This classification is represented using a *triangle*, called the *texture triangle*.



Edaphic factors



Edaphic factors



Edaphic factors

Biologically, *particle size* plays a role in the distribution of animals and groundwater.

Many organisms such as *earthworms* prefer loamy or *sandy clay soils*, species like *beetles* prefer clayey and/or loamy soils, with a high content of *fine elements* and which have the ability to retain the necessary water, compared to *coarse elements* which allow the soil to dry out too quickly.

Earthworms

beetles

Example

Edaphic factors

Soil structure

Structure is the soil organization. It is also defined as the spatial arrangement of *sand*, *silt* and *clay particles*. There are *three main types* of structures.

single-grain (particulate): where the soil elements are not linked, the soil is very moved (*sandy soils*).

Massive: where the elements of the soil are linked by cement (organic matter, limestone) (*clayey soils*).

Edaphic factors

Soil struture

Fragmentary: where the elements are **linked** by organic matter and formed **aggregates** (heterogeneous assembly of substances or elements which **adhere solidly** to each other) with different sizes.

Soil water

Water is present in the soil in four specific states:

Hygroscopic water

comes from **atmospheric moisture** and forms a thin film (**mince pellicule**) around soil particles. It is retained very energetically and cannot be used by living organisms.

Non-absorbable capillary water

occupies pores with a diameter **less than 0.2 mm**. It is also **retained too energetically** to be used by living organisms. Only **very adapted organisms** can use it.

Absorbable capillary water

located in pores with dimensions **between 0.2 and 0.8mm**. Most used by organisms (plantes and animals).

Gravity water

Temporarily occupies the **largest pores** in the soil **(>0.8 mm**). This water flows away under the action of gravity.

Edaphic factors

Soil PH

Soil pH is the result of a combination of various soil factors.

In fact, the soil solution contains H+ ions originating from:

- Alteration of the parent rock.
- Humification of organic matter (humic acid synthesis).
- Biological activity.
- Acidifying fertilizers effect.

Edaphic factors

Soil PH

The pH also depends on the nature of the vegetation cover and the climatic conditions (temperature and rainfall):

Basic pH values (**greater than 7.5**) characterize soils that develop on **limestone parent rock**. They are typically found in **dry or seasonally dry climates** and under vegetation with rapidly decomposing leaves.

Acidic pH (**less than 6.5**) are found much more often in **humid and cold climates** favorable to the accumulation of organic matter. They characterize coniferous forests (boreal forests). They form mainly on **siliceous rocks and granitic** rocks**.**

pH neutral (6.5 ~ 7.5).

Living organisms such as Protozoa tolerate pH variations from 3.9 to 9.7 depending on the species: some are rather **acidophilic** while others are **basophilic** (**alkaline**). **Neutrophils** are the most frequently represented in nature.

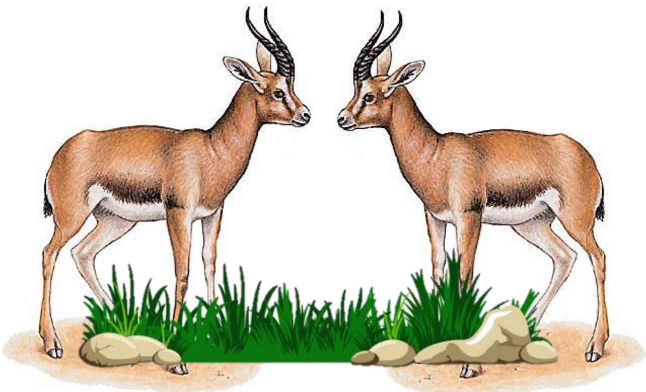
biotic factors

Reminds

Biotic factors are the set of actions that living organisms exert directly on each other. These interactions, called **coactions**, are of two types:

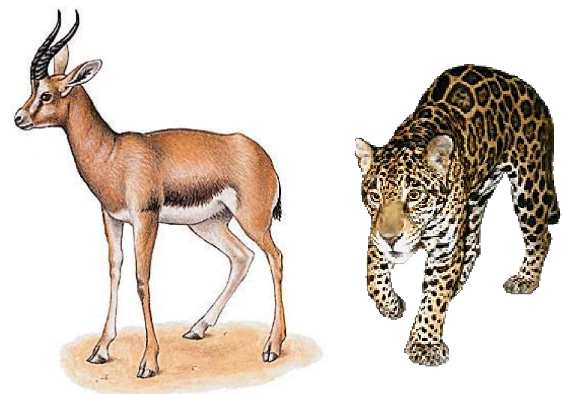
Homotypics

or **intraspecific**, when they occur between individuals of the **same species**.



Heterotypics

or **interspecific**, when they take place between individuals of **different species.**



Homotypic coactions

Living beings can communicate with each other in different ways: **visual**, **sound**, **and chemical.**

Group effect (gregariousness)

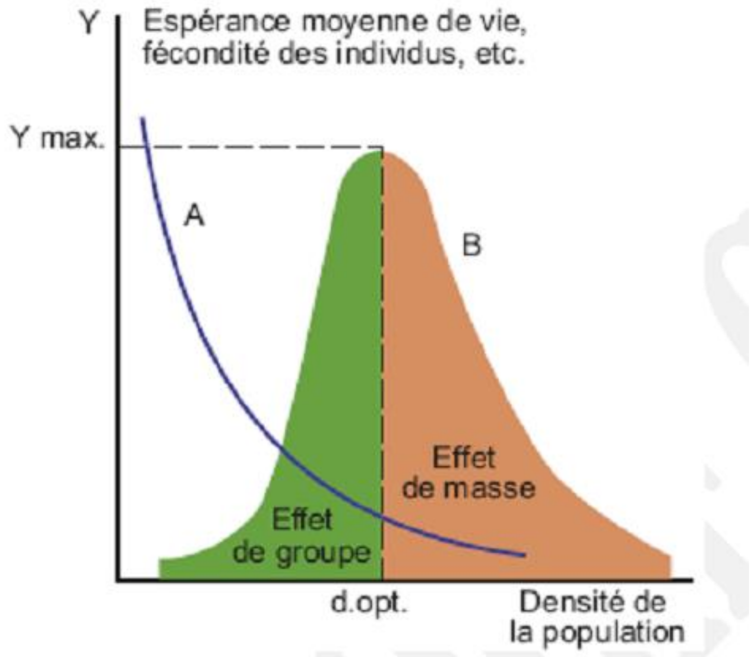
The **group effect** is known in many species of **insects** or **vertebrates**, which can only reproduce normally and survive when they are represented by large enough populations.

Example It is estimated that a herd of **African elephants** must contain at **least 25 individuals** to survive: the fight against enemies and the search for food are made easier by living together.

Homotypic coactions

Mass Effect

Contrary to the group effect, the mass effect occurs when the environment, often **overpopulated**, causes **severe competition** with harmful consequences for individuals. The harmful effects of these competitions have consequences on the metabolism and physiology of individuals which result in **disturbances**, such as a drop in the fertility rate, a decrease in the birth rate, and an increase in mortality. In some organisms, overpopulation leads to phenomena called **self-elimination** phenomena.



Homotypic coactions

Intraspecific competition

This type of competition occurs between individuals in an overpopulated population and can occur at very low densities.

Appears in territorial behaviors, that is to say when the animal defends a certain surface against invasions by other individuals.

Maintaining a ... viduals and dominated inc...

Food competi... species is intense when ... Its most frequent cons... wth rate of populations.

Homotypic coactions

Intraspecific competition

In plants, intraspecific competition, linked to high densities, occurs mainly for water and light. It results in a reduction in the number of seeds formed and/or significant mortality which greatly reduces the numbers.

Cannibalism

A form of predation that occurs between individuals of the same species.

Heterotypic coactions

The cohabitation of two species can have **no influence** on each of them, either **favourable** or **unfavourable** effects.

Neutralism

We speak of neutralism when the two species are independent: they coexist without having any influence on each other. Ex: Species with completely different ecological niches.

Heterotypic coactions

Interspecific competition

Interspecific competition can be defined as the active search, by members of two or more species, for the same environmental resource (food, shelter, egg-laying site, etc.).

In interspecific competition, each species acts negatively on the other. Competition is greater between two species as they are closer together.

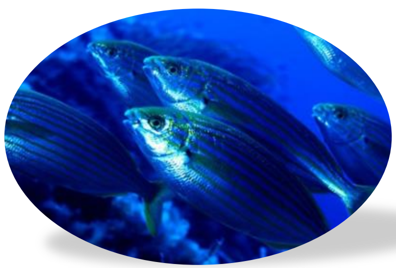
However, two species with exactly the same needs cannot coexist, one of them being necessarily eliminated after a certain time. This is Gause's principle or competitive exclusion principle.

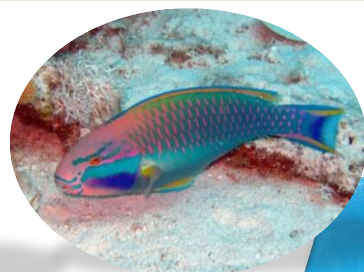
Heterotypic coactions

Predation

A predator is any free organism "**predatory species**" that feeds at the expense of other species called **prey**. Predation is positive to the predator and the prey population because it helps to maintain the balance and health of the latter (the predator primarily targets young, sick or old individuals).

Predators can be polyphagous (attacking a large number of species).



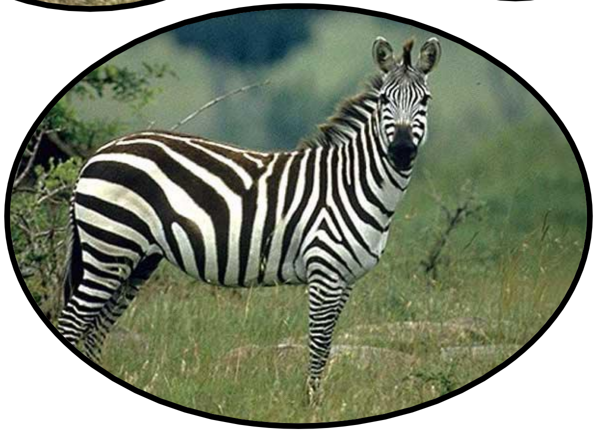


Example




Heterotypic coactions

Oligophagous (feeding on a few species),



Example

Heterotypic coactions

or monophagous (subsisting only at the expense of a single species).

Exemple

Heterotypic coactions

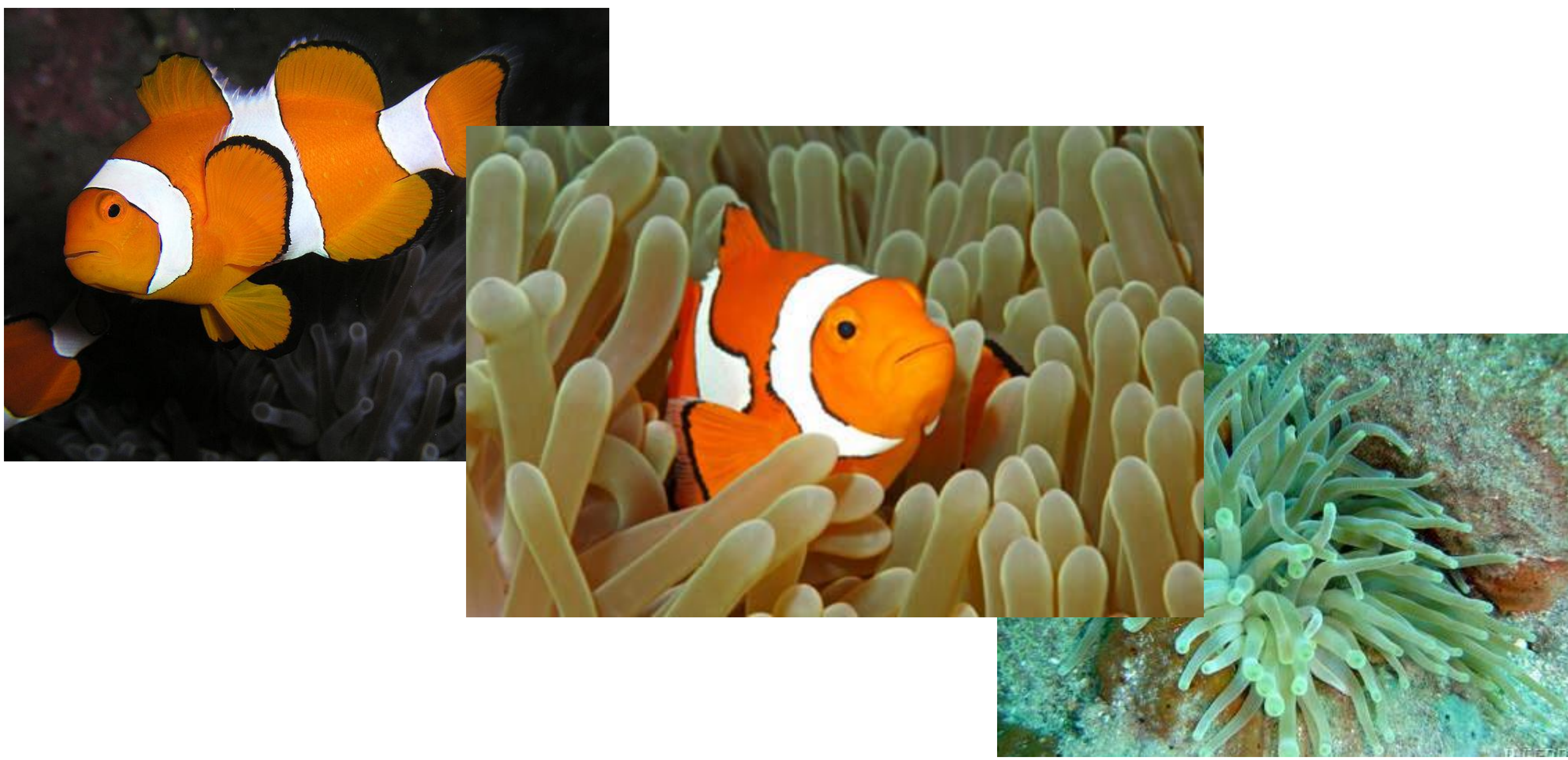
Parasitism

A parasite is an organism that **does not live free** : it is at least, at one stage of its development, linked to the surface (**ectoparasite**) or to the inside (**endoparasite**) of its host.
-Permanent and temporary parasites
-Obligate and facultative parasites.

Parasitism can be considered a **special case of predation**. However, the parasite is not truly a predator because it does not aim to kill the host.

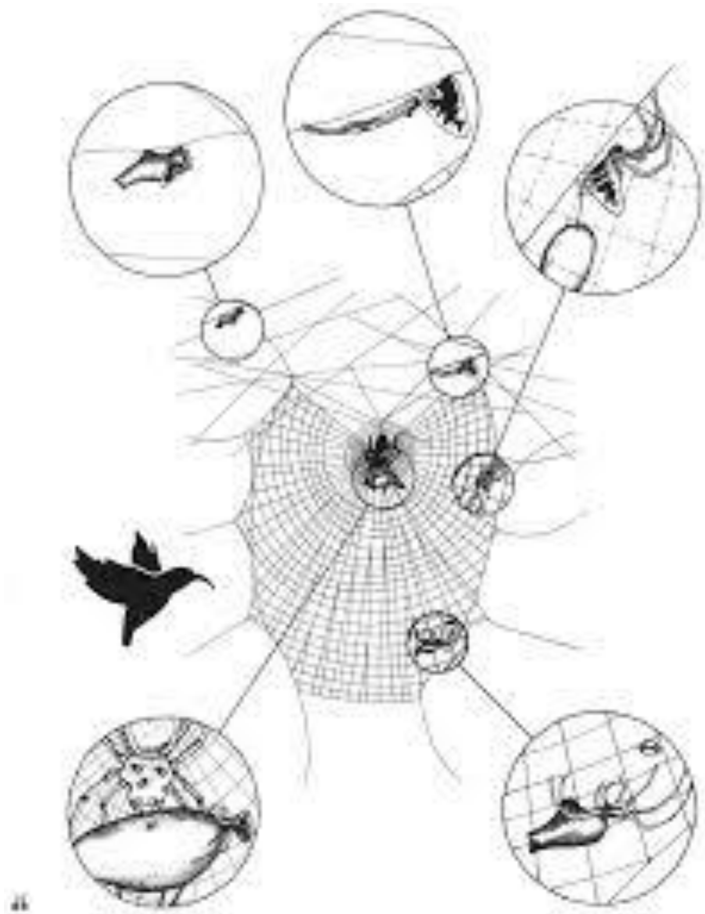

Commensalism

Interaction between a species, called commensal, which benefits from the association and a host species with no benefits or harms.



Kleptobiosis

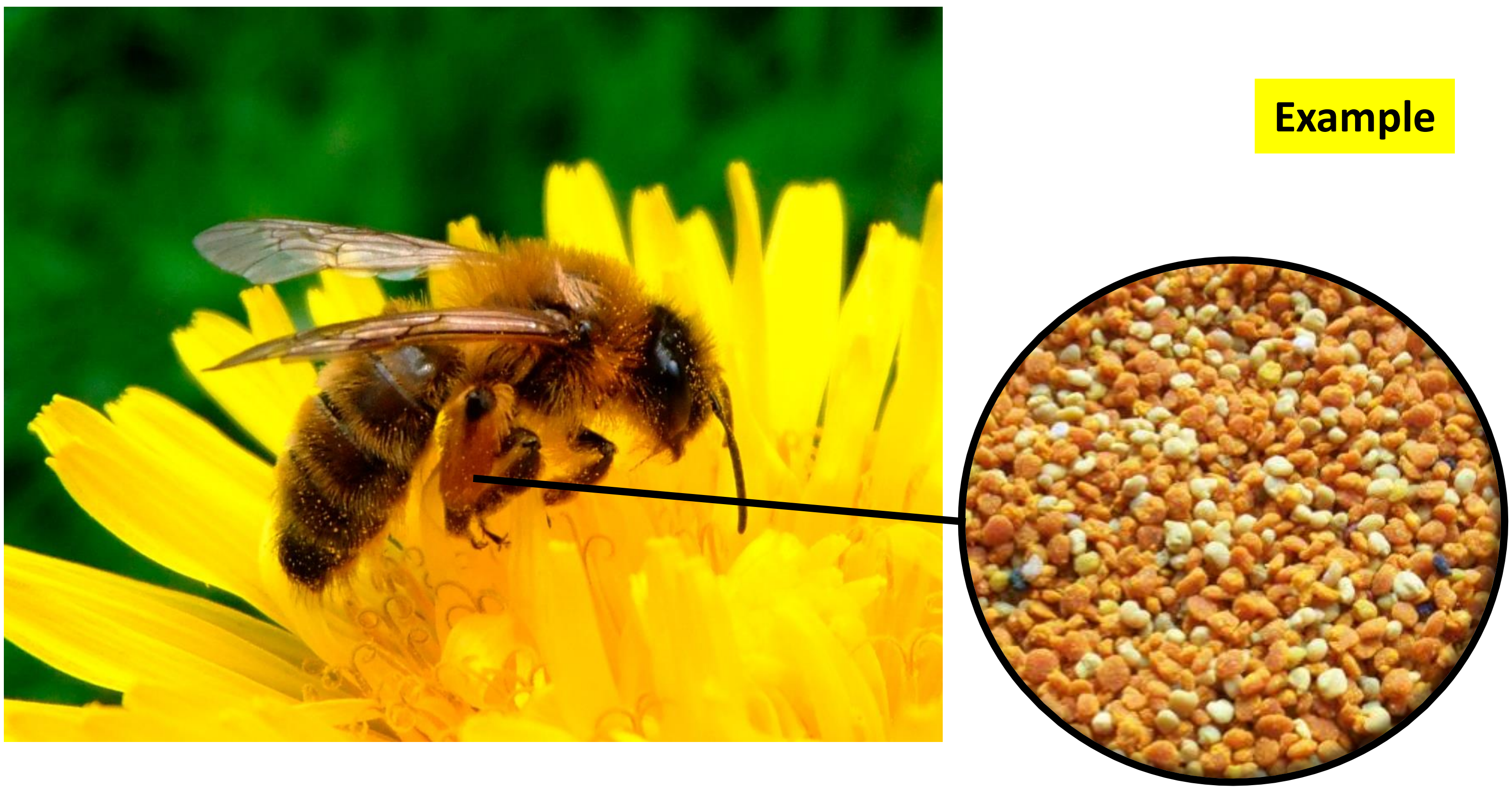
Interspecific association observed in social organisms in which one species steals food collected by another species without living as a commensal in its nest.



Heterotypic coactions

Mutualism

Phenomenon of beneficial association between two living species. This can be facultative (cooperation), or obligatory; it is then called symbiosis.



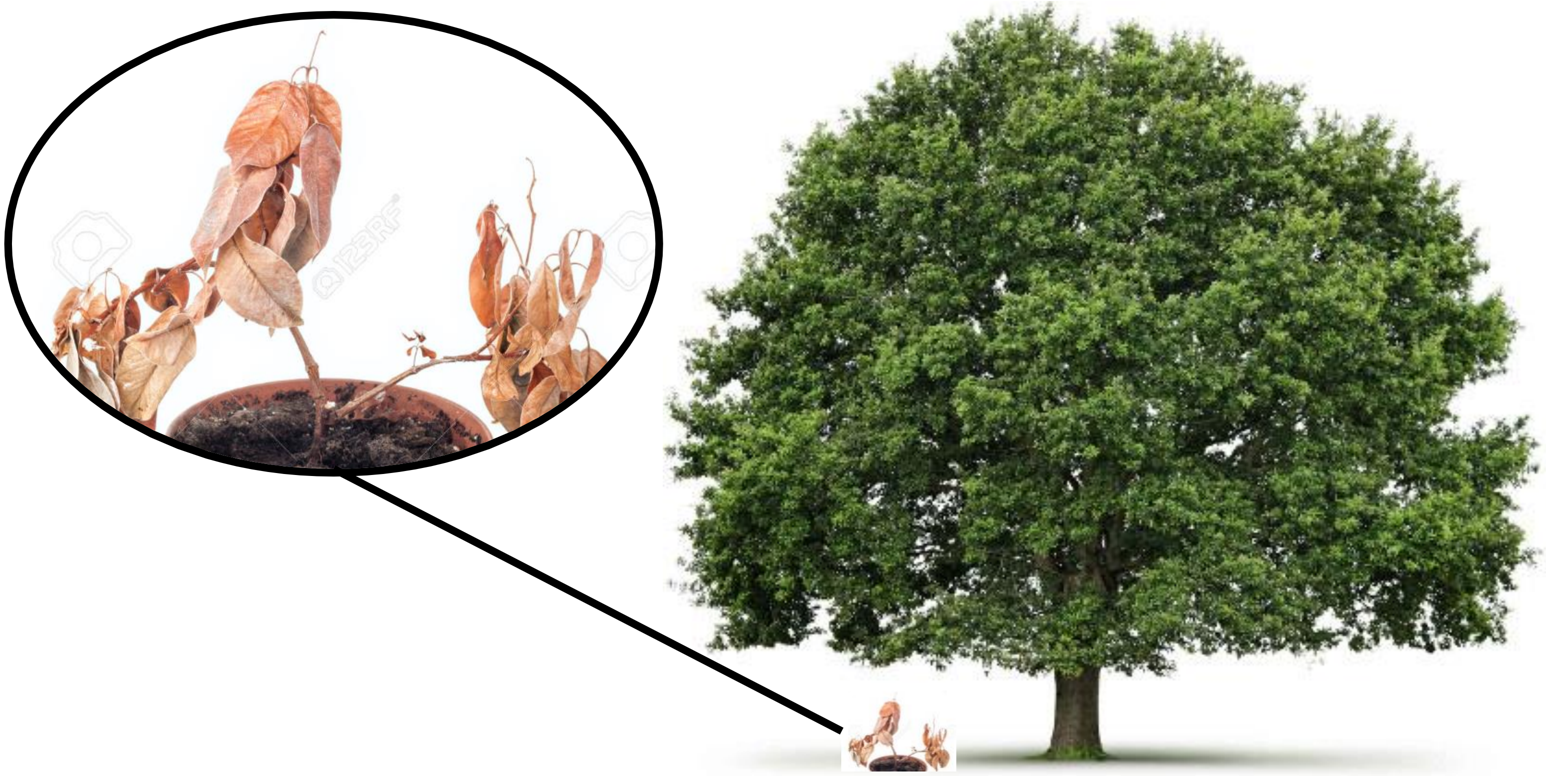
Example

Heterotypic coactions

Amensalism (Antibiosis)

A species is **inhibited** in its growth or reproduction by another **inhibiting species** (**amensal**) which secretes **toxic substances** into the environment. This is a beneficial action for the amensal species but harmful for the other. In interactions between plants, amensalism is often called **allelopathy**.

Example



Heterotypic coactions

Slavery

Form of interaction between different species resulting in some species of ants plundering the nests of another species in order to capture larvae which will then be used as workers in the colony of the dominant species.

CHAPTER III

Ecosystem structure

Biosphere organisation

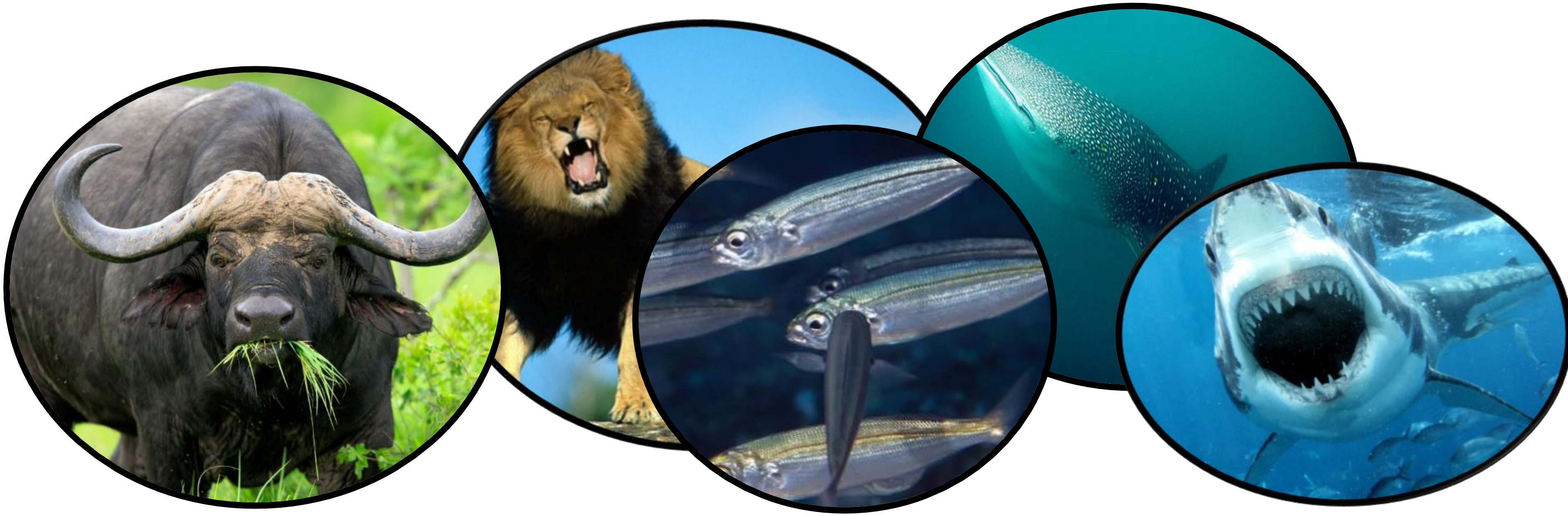
The biotope provides energy, organic and inorganic matter of abiotic origin. The biocenosis comprises three categories of organisms: ***producers*** of organic matter, ***consumers*** of this matter and ***decomposers*** which recycle it.

Producers

These are ***photosynthetic autotrophic*** plants (**green plants**, phytoplankton: cyanobacteria or blue algae: prokaryotic organisms). Having the status of ***primary producers***, they constitute the ***first trophic level*** of the ecosystem. In fact, because photosynthesis they produce organic matter starting from mineral materials provided by the external abiotic environment.

Consumers

These are living beings, called **heterotrophs**, that feed on already developed complex organic matter that they take from other living beings. They consider themselves ***secondary producers***. Consumers occupy a **different trophic level** depending on their **alimentary regim**. A distinction is made between ***consumers of fresh matter*** and ***consumers of corpses***.



Consumers of fresh matter

Primary consumers C1

It is the **phytophages** that eat the producers. These are generally animals, called herbivores (herbivorous mammals, insects, crustaceans: shrimp).

Consumers of fresh matter

Secondary consumers C2

C1 predators. These are **carnivores** that feed on herbivores (carnivorous mammals, raptors, insects, etc.).

Third consumers C3

C2 predators. They are therefore carnivores that feed on
irds, raptors, insects, etc.).

Consumers of corpses.

Scavengers or **scavengers** refer to species that feed on the corpses of fresh or decomposed animals. They often complete the work of carnivores.

Example

Decomposers or detritivores

Decomposers are the various organisms and microorganisms that attack corpses and excreta and gradually decompose them, ensuring the gradual return to the mineral world of the elements contained in the organic matter.

Saprophytic

Plant organism that feeds on decomposing organic matter.

Example

Decomposers or detritivores

Saprophage

An animal organism that feeds on decomposing organic matter.

Example

Decomposers or detritivores

Detritivore

Invertebrate that feeds on detritus or debris from animals or plants.

Example

Decomposers or detritivores

Coprophaga

Animal that feeds on excrement.

Example

Classification of living beings according to their nutritional needs

We distinguish:

Autotrophs (Producers): Chlorophyllous plants (green vascular plants, phytoplankton: cyanobacteria or blue algae: prokaryotic organism) which use solar energy, carbon dioxide, water and mineral salts to transform them into elaborate biochemical matter.

Heterotrophs (Primary Consumers): Depend entirely on autotrophs and can only feed on complex organic matter (carbohydrates, amino acids, etc.) which they obtain directly from autotrophs (phytophages) or indirectly (carnivores).

Parasites (secondary consumers) that obtain their food from hosts that do not necessarily kill.

Saprophytes (Decomposers): Fungi, bacteria, yeasts and other heterotrophic organisms using dead organic matter (plant detritus, excrement and animal carcasses) of which they ensure progressive and total mineralization.

Types of alimentary regim

Alimentary regim varies depending on the species, the seasons, food availability, the animal's activity level, and its stage of development. There is no **alimentary regim** .

We distinguish:

Herbivores or Phytophages: plant consumers classified according to the part of the plant consumed: Radicivores or Rhizophages (roots), Phyllophages or Folivores (leaves), Granivores (seeds), Xylophages or Lignivores (xylem or wood), Carpophages or Frugivores (fruits), Nectarivores (nectar), Polliniphages (pollen), Phytosuccivores (sap), Algophages, Algivores, Phycophages or Fucivores (algae), Mycetophages or Mycophages (fungi).

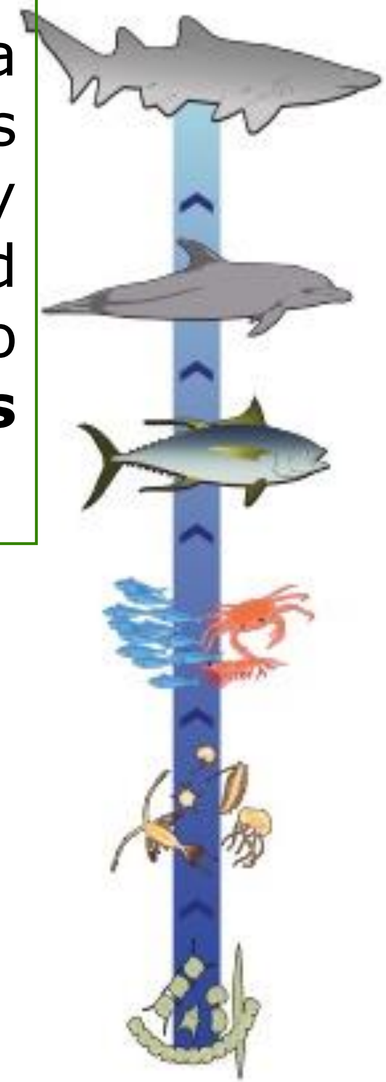
Carnivores : consumers of animals (Zoophages) classified according to the type of animal consumed: Malacophages (molluscs), Oophages (eggs), Entomophages or Insectivores (insects), Acridophages (crickets), Ophidophages (snakes), Ornithophages (birds), Aphidiphages (Aphidians or aphids), Apivores (bees), Piscivores=ichthyophages (Fish), Scavengers= Necrophages=sarcophagus (fresh corpses),…

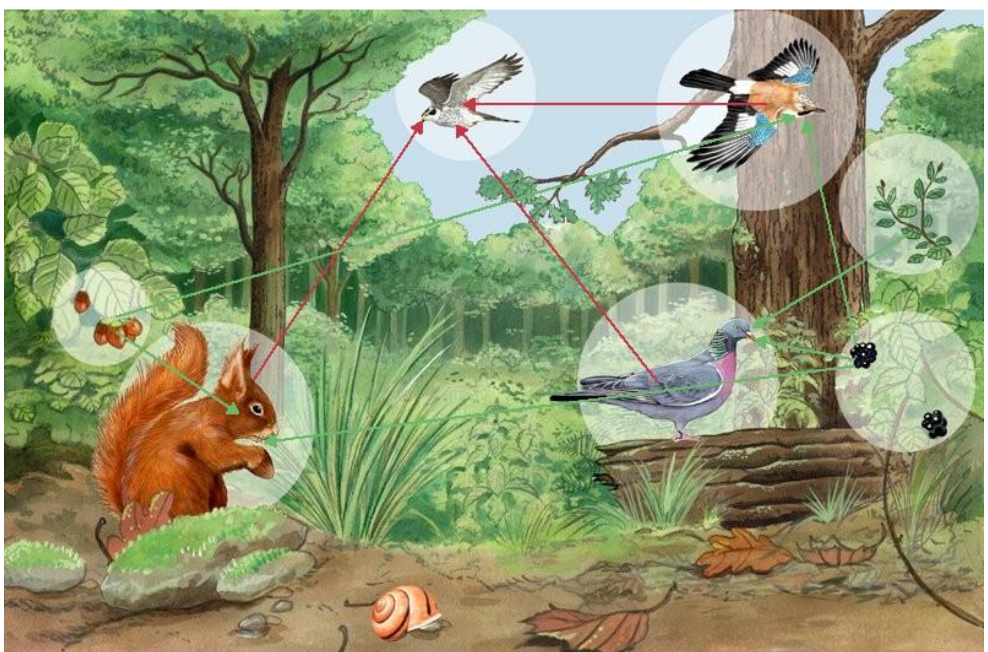
Detritivores or Detritiphages: detritus eaters. In terrestrial environments: Coprophages (excrement), Saprophages (decomposing organic matter), Geophages (humifying organic matter), Necrophages (corpses).

Broad-spectrum consumers: Polyphages (consume both animal and plant foods), Omnivores (very diverse alimentary regim), Microphages (Phyto- and Zooplanktonophages = Megaplankton)

Trophic chain

A **trophic chain** or **food chain** is a succession of organisms, where each lives depended on the previous one. Any ecosystem contains a set of animal and plant species which can be divided into three groups: **producers**, **consumers** and **decomposers**.





Different types of trophic chains

Predator chain

In this chain, the number of individuals decreases from one trophic level to another, but their sizes increase (Elton's rule stated in 1921).

Example **(100) Herbs + (3) Rodent + (1) Fox**

Parasite chain

On the contrary, it goes from big organisms to smaller organisms, but in increasing numbers of individuals.

Example **(01) chenille + (10) Diptera + (20) Hymenoptera**

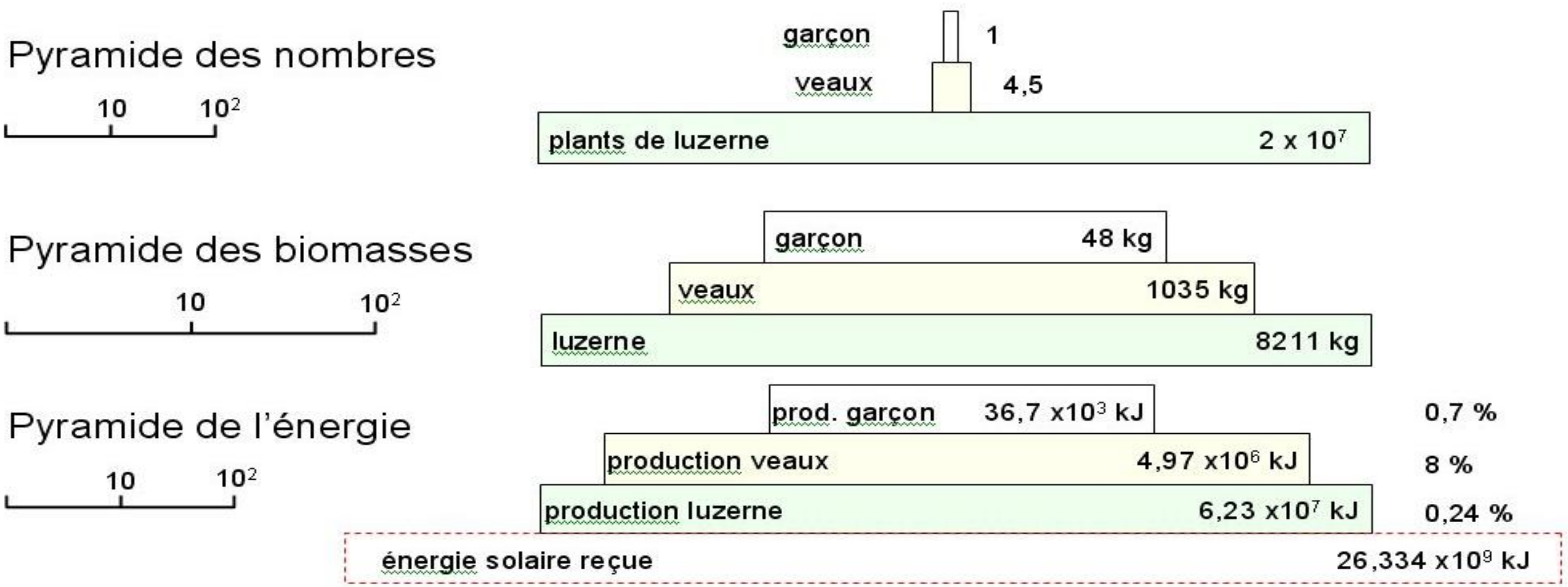
Detritivore chain

Goes from dead organic matter to increasingly smaller (microscopic) and numerous organisms.

Example **(1) Corpse + (80) Nematodes + (250) Bacteria**

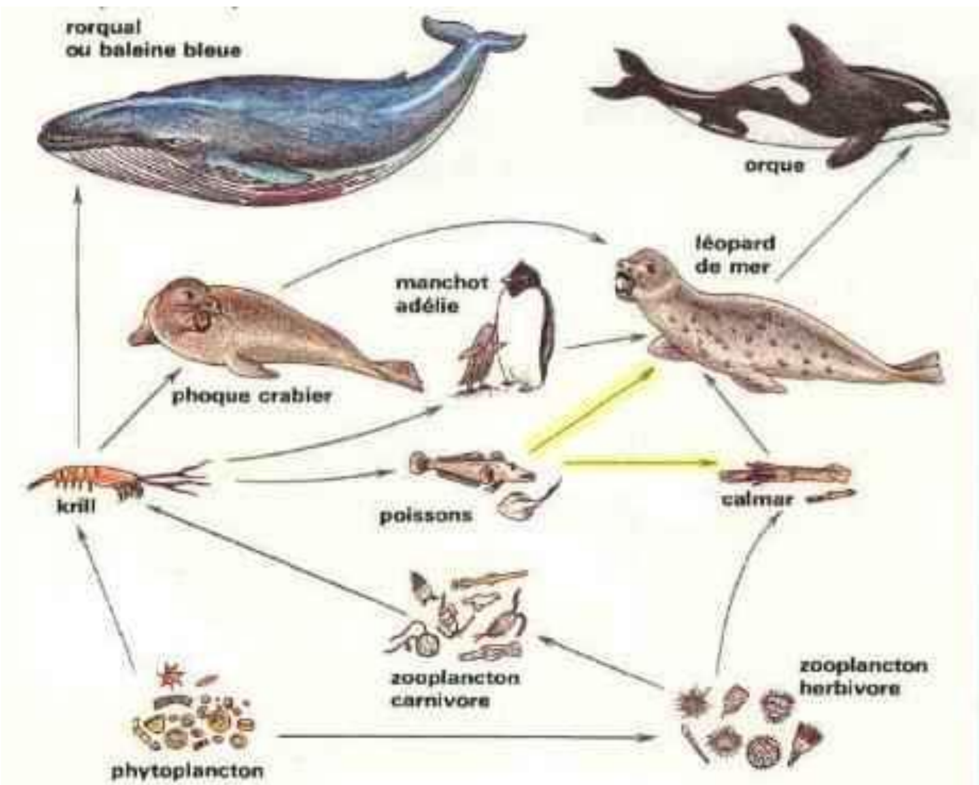
Graphical representation of trophic chains

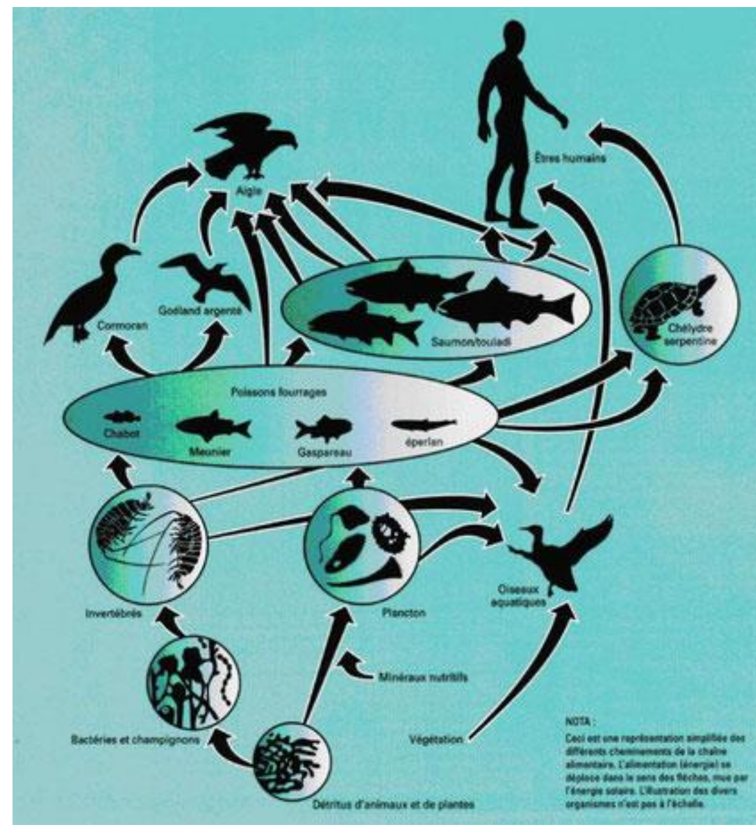
The schematization of the structure of biocenoses is generally designed using ***ecological pyramids***, which correspond to the superposition of horizontal rectangles of the same height, but of lengths proportional to the number of individuals, the biomass or the quantity of energy present in each trophic level. We then talk about a ***pyramid of numbers***, ***biomass*** or ***energy***.



Trophic network

The ***trophic notwork*** is defined as a set of ***alimentary chains*** linked together within an ecosystem and through which energy and matter circulate.





CHAPTER VI

Ecosystem function

Energy transfer and yields

Brute Productivity BP

Quantity of living matter produced during a unit of time, by a given **trophic level**.

Net productivity PN

Raw productivity minus the quantity of living matter degraded by respiration NP= BP – R.

Primary net productivity

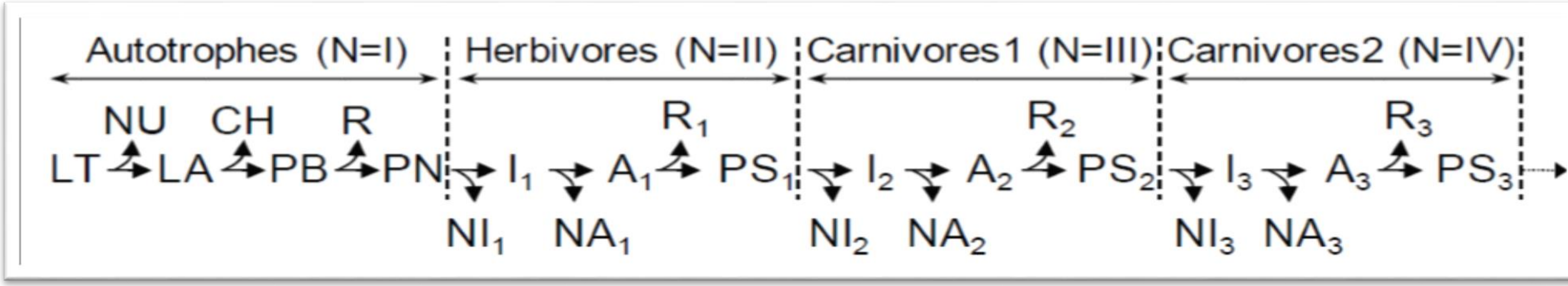
Net productivity of chlorophyll autotrophs.

Secondary net productivity

Net productivity of herbivores, carnivores and decomposers.

Energy transfer

The trophic relationships that exist between the levels of a trophic chain result in transfers of energy from one level to another.



1-Part of the solar light absorbed by plants is lost in the form of heat (CH).

2-The rest is used for the synthesis of organic substances (photosynthesis) and corresponds to **Brute Primary Productivity (BP)**.

3-Part of (**BP**) is lost to **respiration (R1).**

4-The rest is **Net Primary Productivity (PN).**

5- Part of (**PN**) is used to increase plant biomass, The rest of (**PN**) serves as food for herbivores who thus absorb a quantity of **ingested energy** (**I1**).

6-The quantity of **energy ingested (I1)** corresponds to what is actually used or **Assimilated (A1)** by the **herbivore**, plus what is rejected (**Non-Assimilated**) (**NA1**) in the form of excrement and waste: **I1 = A1 + NA1**

7-The assimilated fraction (**A1**) serves on the one hand for **Secondary Productivity** (**PS1**) and on the other hand for **Respiratory expenses** (**R2**).

Thus, from the sun to consumers (1st, 2nd or 3rd order), **energy flows** from trophic level to another trophic level, decreasing with each transfer from one level to another. We therefore speak of **energy flow**.

The further away from the primary producer, the production of living matter is lower

Energy yields

At each stage of the flow, from the eaten organism to the eater organism and within each of them, energy is lost. We can therefore characterize the various organisms from a **bioenergetic point** of view, by their ability to reduce these energy losses. This ability is assessed by **yield calculations**.

Exploitation yield

$$Ce = In / Pn\text{-}1 \times 100$$

In is energy ingested of trophic level **n**
Pn-1 *is net productivity of trophic level* ***n-1***

Assimilation yield

$$Ae = An / In \times 100$$

An is energy assimilated of trophic level **n**
In is energy ingested of trophic level **n**

Net production yield

$$Py = Pn/An \times 100$$

Pn *is net productivity of trophic level* ***n***
An is energy assimilated of trophic level **n**

This yield is of interest to breeders because it expresses the possibility for a species to produce the greatest possible quantity of meat from a given quantity of food.

Brute production yield

$$By = Pn/In \times 100$$

Pn *is net productivity of trophic level* ***n***
In is energy ingested of trophic level **n**

Ecological yield

$$Ey = Pn/ Pn\text{-}1 \times 100$$

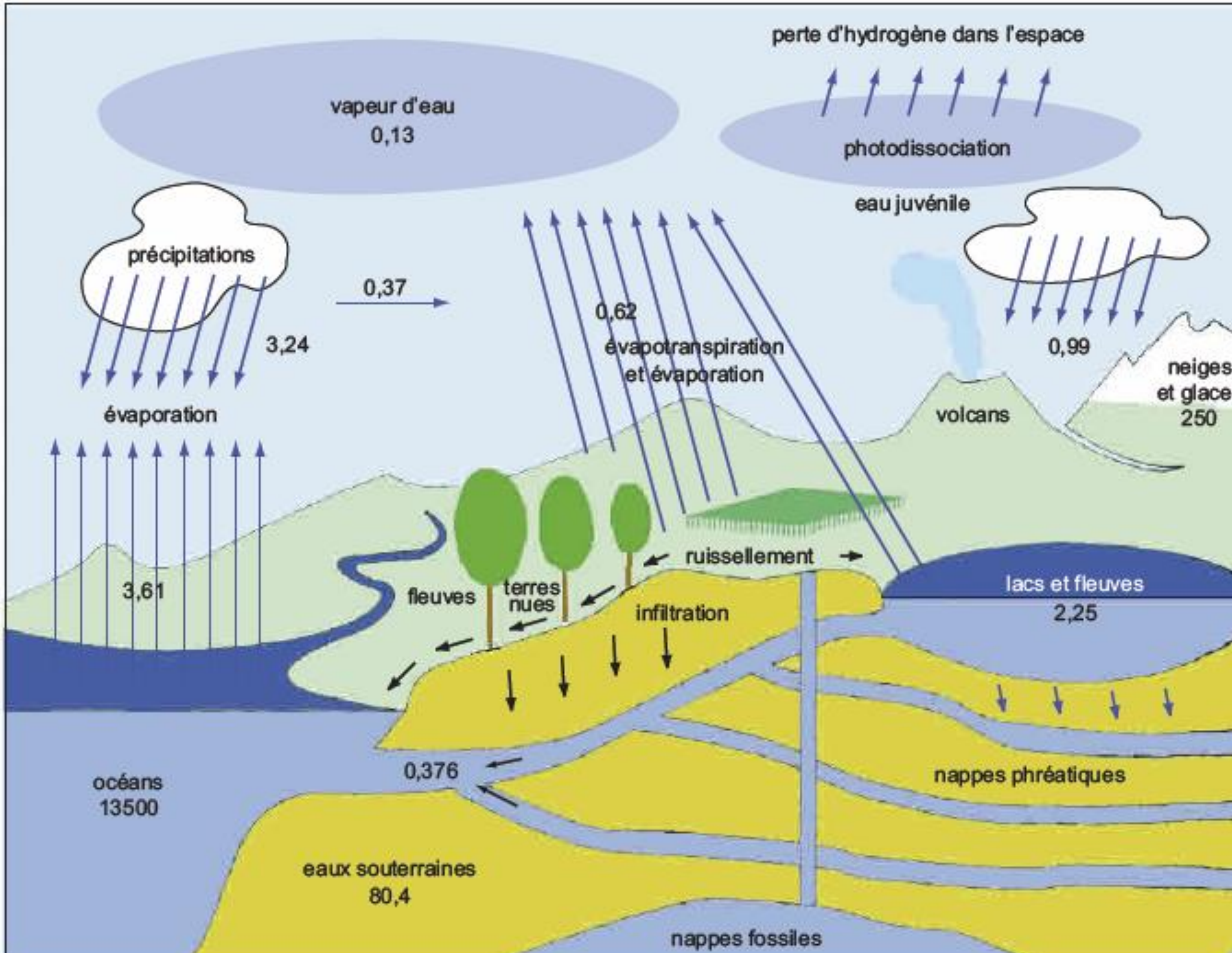
Pn *is net productivity of trophic level* ***n***
Pn-1 *is net productivity of trophic level* ***n-1***

Biogeochemical cycles

There is a circulation of matter in each ecosystem where molecules or chemical elements constantly return to their starting point and which can be described as **cyclical**. The alternating passage of elements, or molecules, between **inorganic environment** and **living matter** is called **biogeochemical cycle**. This corresponds to a **biological cycle** (**internal cycle** in the ecosystem which corresponds to exchanges between organisms) to which is added a **geochemical cycle** (**large-scale cycle**, which can affect the entire biosphere and which concerns transport in the non-living environment).

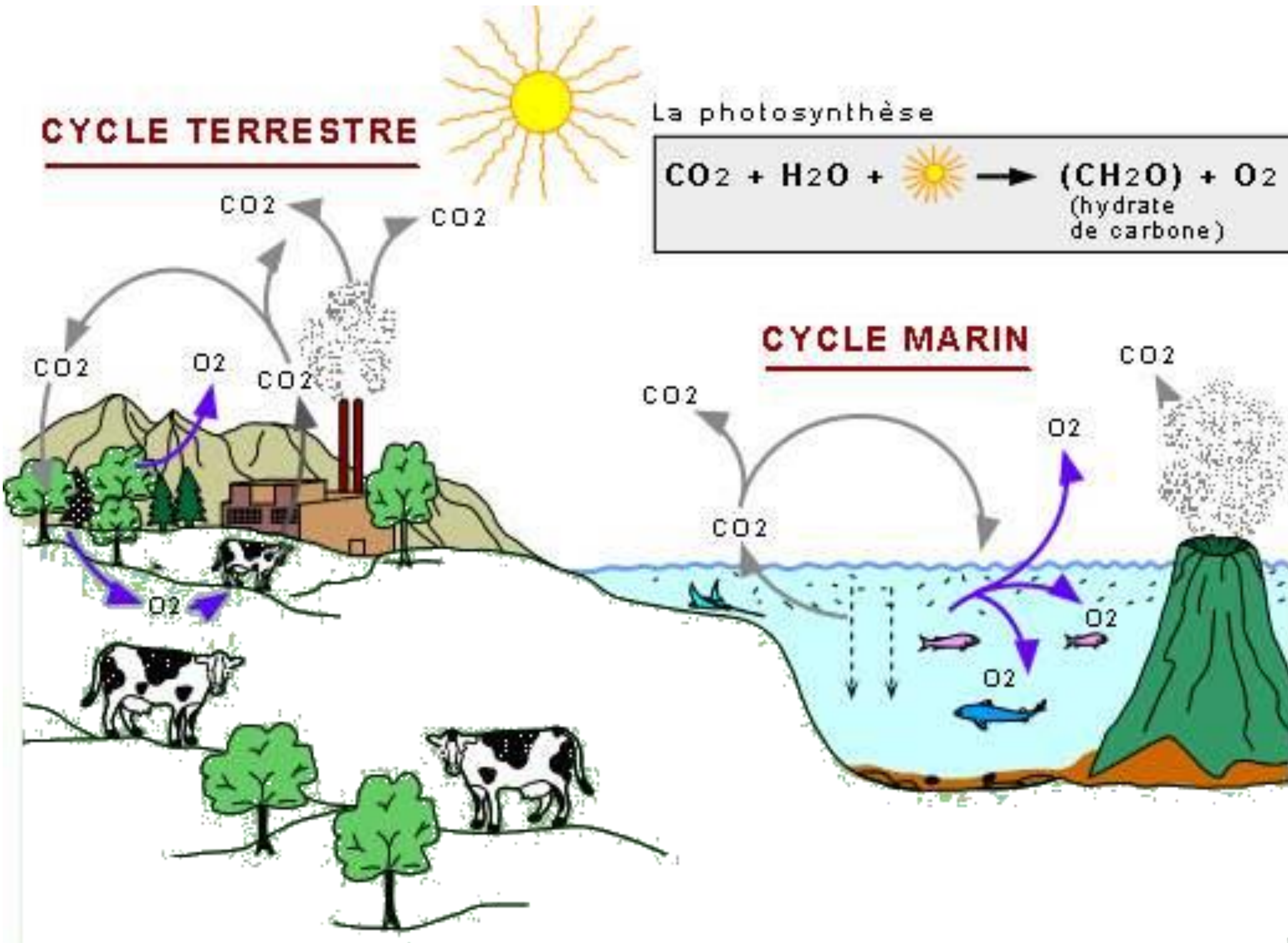
Three main types of biogeochemical cycles can be distinguished:
1-The **water cycle**.
2-The cycle of elements with **a predominantly gaseous phase** (**carbon, oxygen, and nitrogen**).
3-The cycle of elements with a **predominantly sedimentary phase** (**phosphorus, potassium, sulfur, etc**.).

1-**Water cycle**



2- Carbon cycle

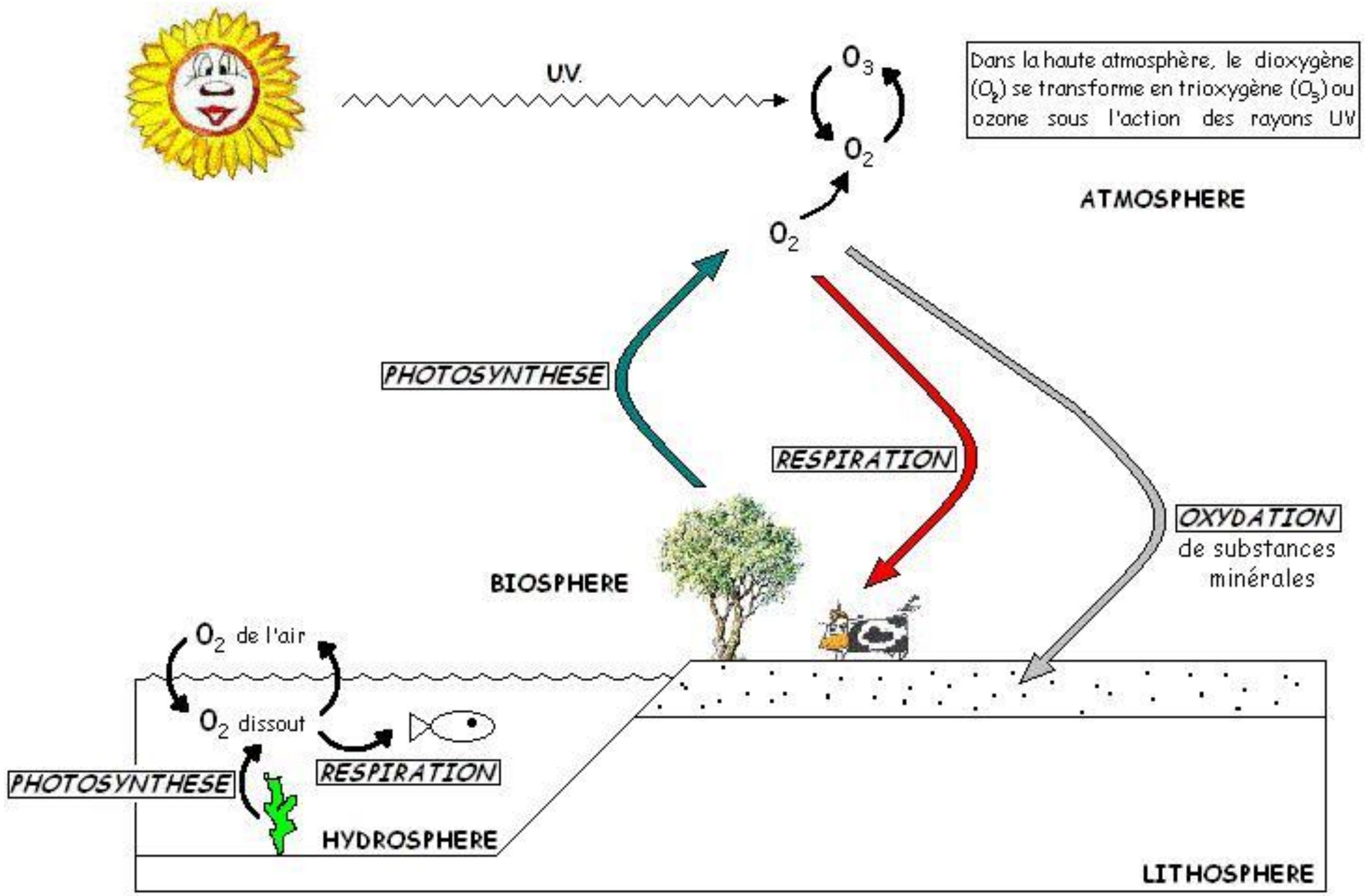
This cycle is regulated by two antagonistic processes: **photosynthesis** and **respiration**. There is a decoupling between that of this element in the continental environment and in the Ocean. Indeed, the exchanges of CO_2 between the air and **terrestria**l biocoenoses are **relatively rapid**. On the contrary, those which take place between the **hydrosphere** and the atmosphere **are slower** because the World Ocean contains a very large stock of dissolved CO_2 (and particulate carbon).



CYCLE TERRESTRE
La photosynthèse
$CO_2 + H_2O +$ [sun] $\rightarrow (CH_2O) + O_2$
(hydrate de carbone)
CO2
CO2
CO2
O2
CO2
O2
CYCLE MARIN
CO2
CO2
O2
CO2
O2
O2

3-Oxygen cycle

This cycle complements that of carbon: the absorption of oxygen by ecosystems resulting from **respiration**, a process antagonistic to **photosynthesis**, compensates for the emission of this element through the primary production of their plant community (or phytoplankton in the marine environment).



4-Phosphorus cycle

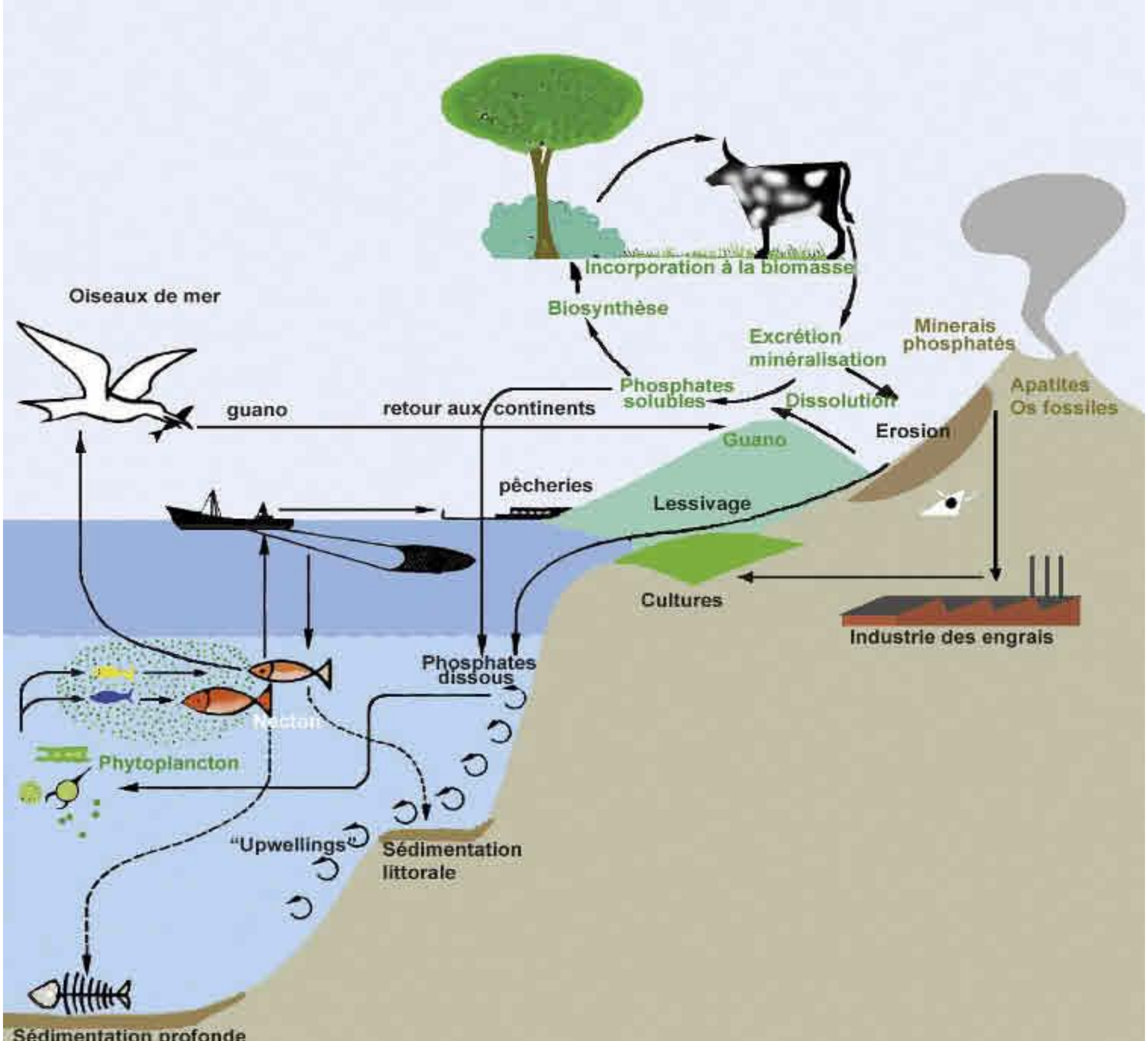
The phosphorus cycle is unique among major biogeochemical cycles because it has **no gaseous component**. Therefore, it practically does not affect the atmosphere.

Phosphorus in the soil

The available mineral phosphorus stock is entirely contained in the lithosphere where it is found mainly in igneous rocks (apatites) and sedimentary deposits (phosphorites for example)

In ocean

The phosphorus stock is contained in the sediments, the main reserve of phosphate available to living beings is found dissolved in deep waters.

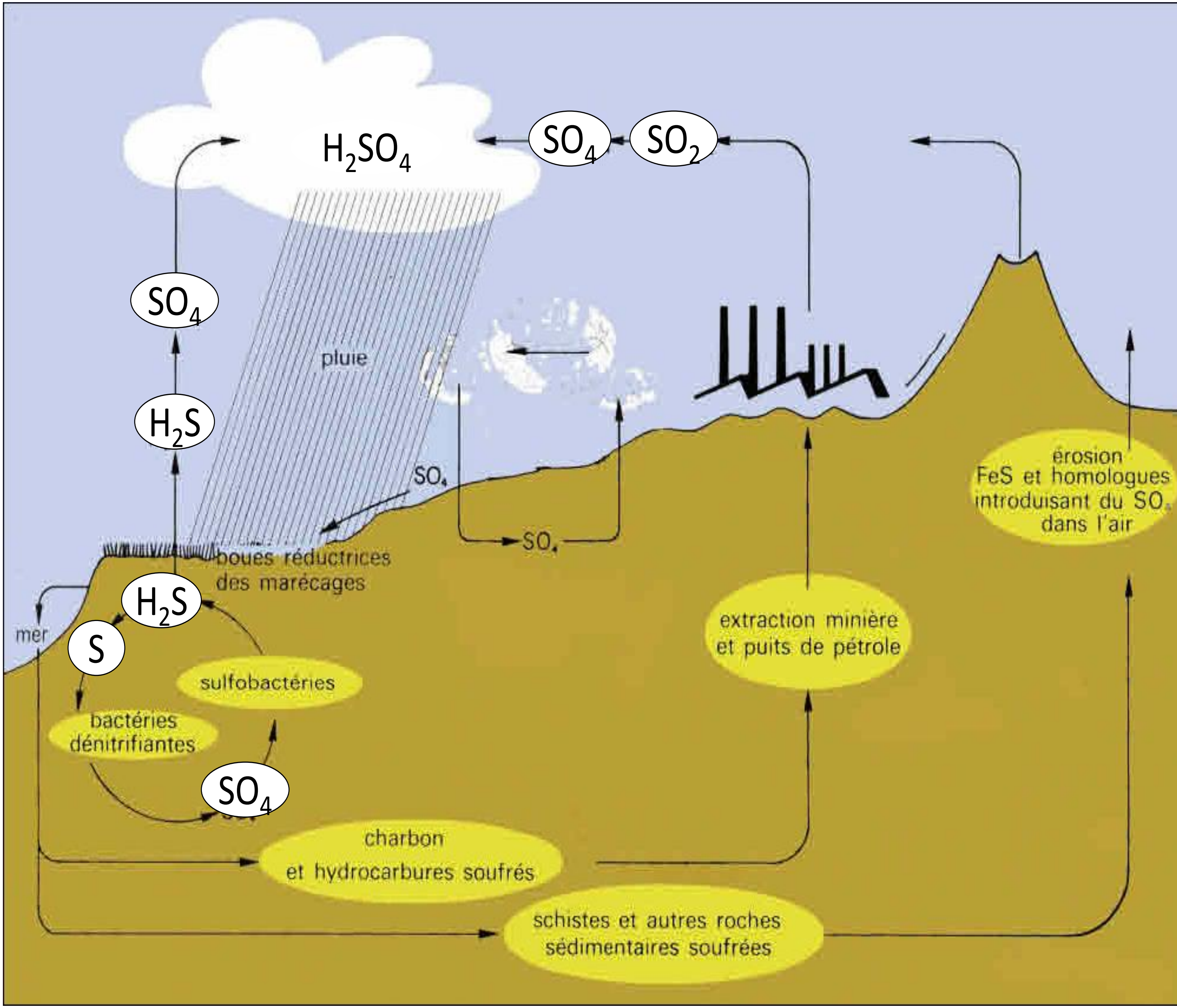


Incorporation à la biomasse
Biosynthèse
Excrétion
minéralisation
Minerais
phosphatés
Oiseaux de mer
Phosphates
solubles
Dissolution
Apatites
Os fossiles
guano
retour aux continents
Guano
Erosion
pêcheries
Lessivage
Cultures
Industrie des engrais
Phosphates
dissous
Necton
Phytoplancton
"Upwellings"
Sédimentation
littorale
Sédimentation profonde

5. Sulphur cycle

Despite the existence of various gaseous sulfur compounds, such as hydrogen sulfide (H2S) and sulfur dioxide (SO2), the majority of the cycle of this element is sedimentary in nature and takes place in water and soil.

1. The sulphur is released by the altering of rocks.
2. Sulphur comes in contact with air and is converted into sulphates (SO_4^{2-}).
3. Sulphates are taken up by plants and microbes and are converted into organic forms.
4. The organic form of sulphur is then consumed by the animals through their food and thus sulphur moves in the food chain.
5. When the animals die, some of the sulphur is released by decomposition while some enter the tissues of microbes.
6. There are several natural sources such as volcanic eruptions, evaporation of water, and breakdown of organic matter in swamps, that elaborate sulphur directly into the atmosphere. This sulphur falls on earth with rainfall.



H_2SO_4
SO_4
SO_2
SO_4
H_2S
pluie
SO_4
SO_4
boues réductrices des marécages
H_2S
S
mer
sulfobactéries
bactéries dénitrifiantes
SO_4
charbon et hydrocarbures soufrés
schistes et autres roches sédimentaires soufrées
extraction minière et puits de pétrole
érosion FeS et homologues introduisant du SO dans l'air

6-Nitrogen cycle

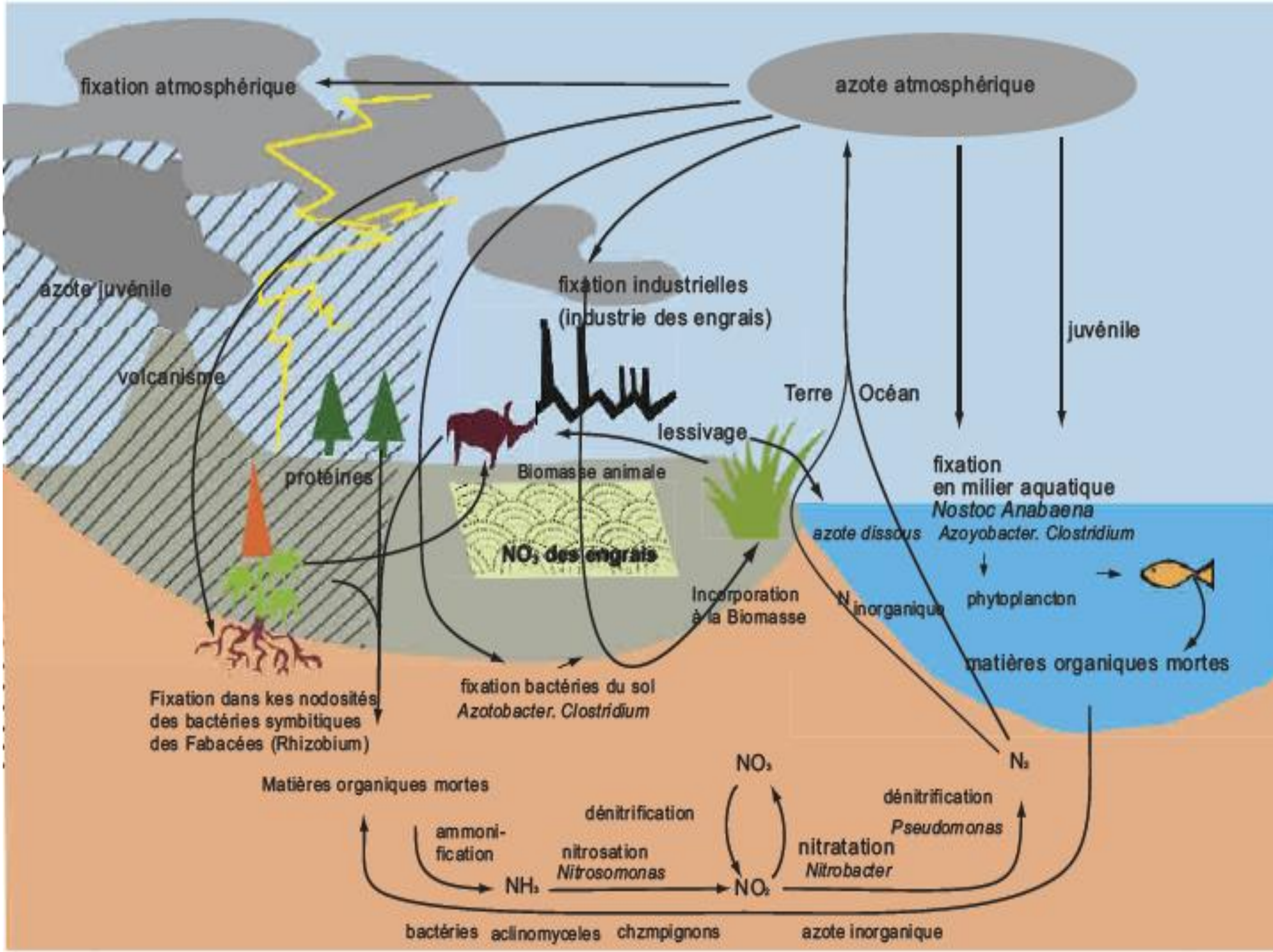
1-Nitrification: The formation of nitrates by inorganic means is constantly taking place in the atmosphere as a result of **electrical discharges** during storms. However, it plays only a secondary role compared to that of nitrifying microorganisms. The latter are mainly represented by bacteria, either free-living (**Azotobacter, Clostridium, Rhodospirillum**) or symbiotic (**Rhizobium**). In the aquatic environment, it is mainly cyanophycean algae (blue-green algae) that fix gaseous nitrogen.

2-Assimilation: The nitric nitrogen produced by these numerous terrestrial and aquatic microorganisms is ultimately absorbed by plants, taken to the leaves, and transformed into ammonia by a specific enzyme, **nitrate reductase**. The ammonia is then transformed into amino nitrogen and then into proteins.

3-Ammonification: Proteins and other forms of organic nitrogen contained in corpses, excreta and organic waste will be attacked by bio-reducing microorganisms (bacteria and fungi) which produce the energy they need by decomposing this organic nitrogen which is then transformed into ammonia, this is ammonification.

4-Nitrification: Some of this ammoniacal nitrogen can be "absorbed directly by plants," but it can also be used by nitrifying bacteria (**Nitrosomonas**) to produce their metabolic energy. These bacteria transform ammonia **NH4+** into **nitrite**, **NO2-**, which is **nitritation**, then **Nitrobacter** transforms it into **NO3-**, which is **nitration**. "The nitrate ion NO3- is then absorbed by plants."

5. Denitrification: Nitrogen constantly returns to the air under the action of denitrifying bacteria (**Pseudomonas**) which are capable of decomposing the **N03**- ion into **N2** which **volatilizes** and returns to the **air**; but the role of these bacteria is fortunately of little importance because **denitrification** returns nitrogen to the atmosphere in its molecular form **N2**



fixation atmosphérique
azote atmosphérique
azote juvénile
fixation industrielles
(industrie des engrais)
juvénile
volcanisme
Terre
Océan
lessivage
protéines
Biomasse animale
fixation
en milier aquatique
Nostoc Anabaena
azote dissous
Azoyobacter. Clostridium
NO₃ des engrais
Incorporation
à la Biomasse
N inorganique
phytoplancton
matières organiques mortes
fixation bactéries du sol
Azotobacter. Clostridium
Fixation dans kes nodosités
des bactéries symbitiques
des Fabacées (Rhizobium)
Matières organiques mortes
NO₃
N₂
dénitrification
dénitrification
Pseudomonas
ammoni-
fication
nitrosation
Nitrosomonas
nitratation
Nitrobacter
NH₃
NO₂
bactéries
aclinomyceles
chzmpignons
azote inorganique

Influence of human activities on biological balances

Pollution

Pollution is the degradation of an ecosystem by the introduction, generally human, of substances or radiation altering to a greater or lesser extent the functioning of this ecosystem.

The concept of **pollution** is the contamination of one or more components of ecosystems (air, water, and soil), of an organism (which can be **anthropic**) or of a group of organisms, or having an impact on the ecosystem.

Contamination can notably spread or change via the trophic network (food chain) (**bioconcentration**).

Human being origin

Pollution of **human origin**, also called **anthropogenic**. This pollution is a direct or indirect diffusion of pollutants into the environment.

They are often a products of **human activity origin** . Like consumer **waste** (packaging, used batteries) thrown without precautions into the biophysical and human environment, they are also a very common source of pollution.

Global Change

The English expression **global change**, which means "**global change**", refers to a set of human-induced disturbances that affect all or a significant part of the biosphere.

Many international programs are devoted to this subject, which has three main themes: the **greenhouse effect**, the **ozone layer** and **acid rain**.

greenhouse effect

The use of **fossil fuels** (**coal**, **oil**, **natural gas**) elaborates into the atmosphere some of the carbon that was stored underground in the form of fossil carbon.

The **carbon dioxide** content of the atmosphere had apparently still stable for centuries at around **290** parts per million (ppm). It has increased since about **1850** and is now **350 ppm.**

This significant change is already causing changes in the general state of the biosphere, and in particular leading to an amplification of the greenhouse effect. **Since 1850**, the average temperature of the earth's surface has increased by almost **1°C.**

Experts predict that if the increase in atmospheric carbon dioxide content keep going with this rate, the temperature rise within a century will be between **2 and 6** degrees Celsius.

Methane, which emissions originate from anaerobic organic decomposition (**rice fields, soils, and landfills**) and **microbial fermentation** of food in the digestive tract of livestock, as well as **chlorofluorocarbons (CFCs**) have the same effect and are also released into the atmosphere in increasing quantities.

Ozone layer

In the stratosphere, at an altitude of around 40 km, there is a layer of **ozone (O3)** which is formed by photochemical reactions: a combination of molecular **oxygen (O2)** and **atomic oxygen (O)** with **solar radiation** presence.

This **ozone layer** blocks a large part of the **sun's ultraviolet** rays and without it no life would be possible on Earth.

A worrying decline in the amount of ozone above Antarctica was detected between **1970 and 1980**.

This destruction of ozone is linked to the use in various industries products (**air conditioning, refrigeration, solvents, aerosols**) of compounds based on **fluorine** and **chlorine** (known as **Freon**) which are commonly called **chlorofluorocarbons (CFCs).**

CFCs, which have a lifespan of **60 to 120 years**, rise to the stratosphere, where the sun's rays break them, generating the **highly reactive chlorine**, which breaks the ozone molecules. Each chlorine molecule can destroy up to **100,000 ozone molecules** without disappearing.

Exposition to **higher doses** of **ultraviolet rays** has harmful consequences for animals and plants. In fact, ultraviolet rays **slow down** the **process of photosynthesis**, affect the growth of **phytoplankton** in the oceans.

In **humans**, the most obvious effects of **ultraviolet rays** are the increase in the number of **skin cancers** and **cataracts**, as well as the decrease in the activity of the **immune system**, which is particularly involved in the fight against infectious diseases.

Acid rain

Acid rain, like the greenhouse effect, is a consequence of the use of **fossil fuels**. It is caused by generating of **sulfur dioxide** (or **sulfurous gas**) and **nitrogen oxide** into the atmosphere during combustion. In the presence of **solar ultraviolet rays**, they react with **atmospheric water vapor** and **oxidants such as ozone**, transforming into **sulfuric acid (H_2SO_4)** and nitric acid(**HNO_3**), which are moved away from their place of production by **atmospheric currents**.

These acidic particles deposited and accumulate on **tree leaves**, then are **washed** away by rain or snow. This leaching then leads to an **increase** in **acidity in the soil**.

Acid rain metals corrosion, alters **stone buildings**, **destroys vegetation**, **slows tree growth,** and **acidifies lakes**, causing fish to disappear.

Localized pollution

Alongside **generalized pollution** across almost the entire planet, there is a large types of pollutions, still relatively localized, but which are becoming more and more widespread.

Atmospheric pollution

It’s the pollution of urban air by **sulfur dioxide** from the **combustion of fossil fuels** and by nitrogen oxides produced by motor vehicle.

Polluted city air contains **ozone, nitrogen oxides, and sulfuric acid**. In certain urban areas, such as **PIKIN**, located in sunny regions, a **grayish covering** is frequently formed - containing **toxic gases** - due to photochemical reactions activated by solar rays. This toxic fog is known as "**SMOG**."

This **atmospheric pollution** is responsible for a growing number of **respiratory illnesses**, especially among **children** and **fragile adults**.

Pesticide pollution

Pesticides are products intended to control harmful insects (insecticides), weeds (herbicides) or harmful fungi (fungicides). after 1945, several synthetic insecticides belonging to the group of **chlorinated hydrocarbons** (the best known of which is **DDT**, **ethylene dibromide - a carcinogen** -) and their common use in the conntrolling insects that are pests of crops and harmful to humans, had catastrophic effects.

They can **accumulate in soil**, **water c**orps (rivers and lakes), **in plant and animal tissues**,. Insecticides sprayed on crops are diffused into the atmosphere and found all over the world, contaminating areas such as the **polar regions** that are far way from cultivated areas.

Nuclear pollution

Although atmospheric **nuclear weapons testing** has been stopped by most countries, eliminating a major source of radioactive pollution.

However, this remains a worrying issue. Nuclear power produces limited quantities of radioactive waste into the air and water, but the risk of accidents remains and the problems related to waste stockage are far way from being resolved. Indeed, due to their radioactive properties, the nuclear waste remains toxic for long periods ranging from a few centuries to several million years.

In 1986, nuclear accident at the Chernobyl, located in the USSR and now in Ukraine. According to some estimates, **150,000 people died in Russia**, while thousands peoples were affected by **thyroid cancer, cataracts and sterility.**

Water pollution

The supply of drinking water has become difficult in many countries. In fact, only **1%** of the water on Earth can be captured from **aquifers or rivers**, while **97%** of this water is found in the oceans, making it **unusable** (except through the expensive method of desalination of seawater).

In many agricultural or intensive livestock farming regions (such as Brittany, where there is a density of 250 pigs per square kilometer due to the proliferation of industrial piggeries), groundwater reserves are contaminated by nitrates from either an excess of **nitrogen fertilizers** or from the **manure of domestic animals**, cows and pigs.

World Health Organization (WHO) standards, which require drinking water to contain **less than 40 mg** of **nitrates** per liter, are not being met in many cases.

Indeed, water treatment stations able to extracte nitrates are still very rare because they are expensive, which also leads to an increase in the price of drinking water. Thus, in poor countries, the use of unsafe water causes diseases that kill ten million people each year.

Chapter V

Brief description of the main ecosystems

- **Forest, grassland, surface waters, ocean**

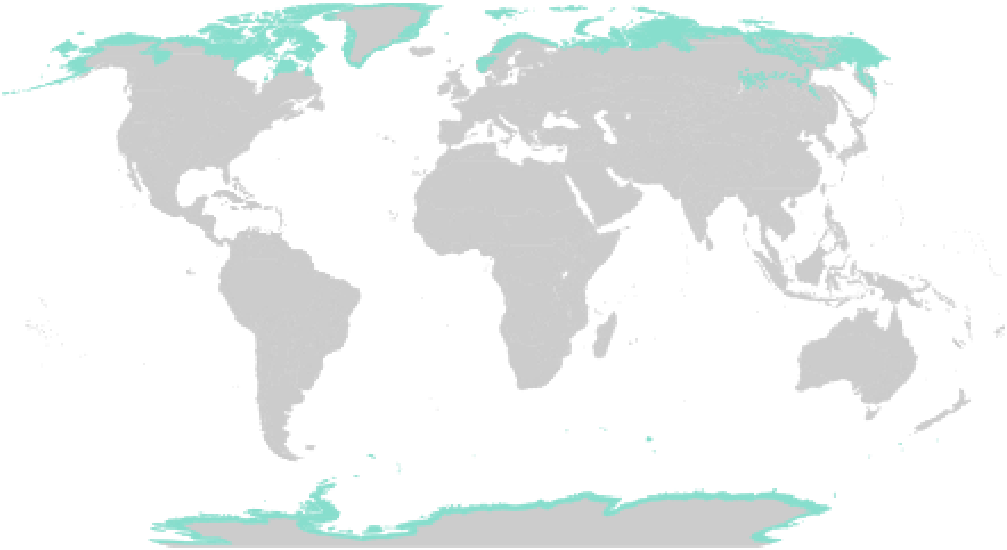
Biome

"**Biomes**" are homogeneous biogeographic groupings of ecosystems by climatic regions covering a vast area (tundra, steppe, etc.).

in fact, each biome is "a large region characterized by a particular combination of **soils**, **plants** and **animals** with a certain **climate**".

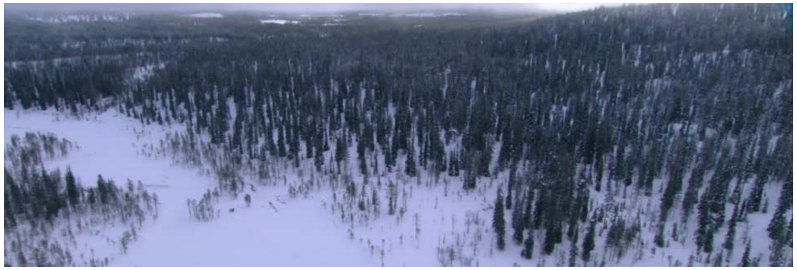
Tundra

Located in the most northern latitudes, This biome is characterized by long, harsh winters and very short summers. It is dominated by moss, lichen and grass.



Taiga (northern conifer forest

Situated to the south of the tundra, this biome is dominated by conifers. It is an immense evergreen space in North America and Northern Europe. The dominant plants are fir and pine.

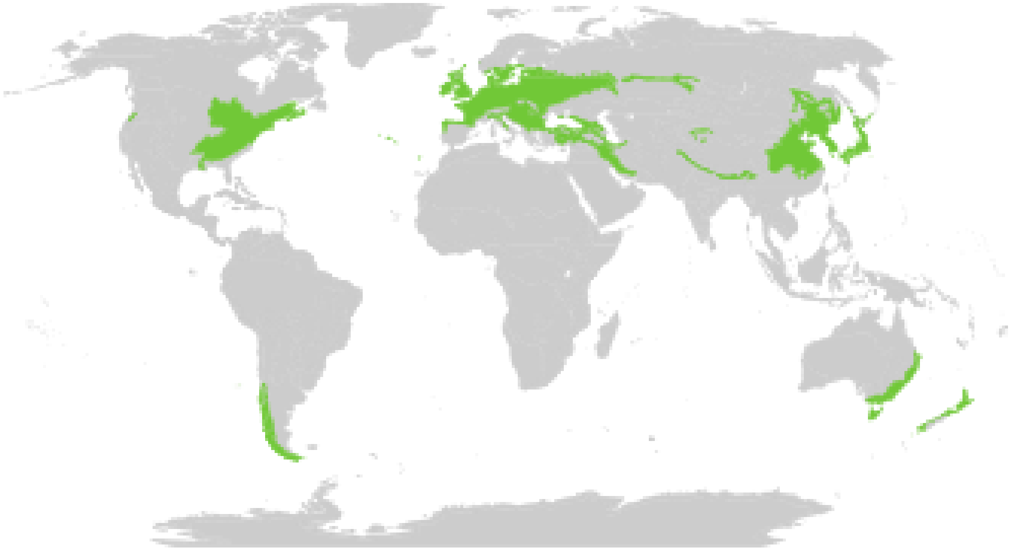


Temperate humid forest

This biome is composed of coniferous forests located in the middle-latitudes. It is characterized by high annual rainfall, cold weather and dense fogs.

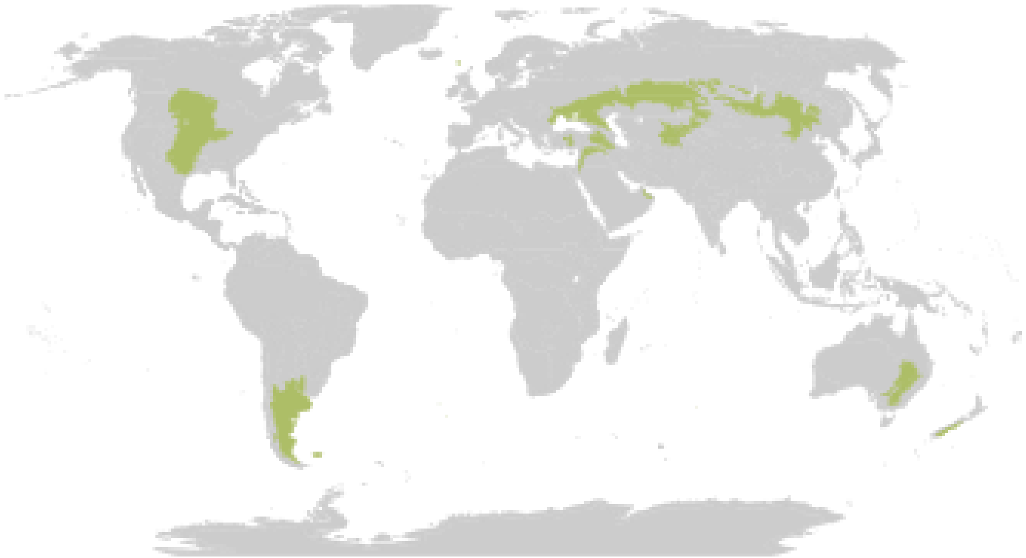
Deciduous temperate forest

Annual precipitation is ranged between 750 to 1250 mm. This biome is dominated by dense forest of broadleaf trees and underneath by young trees and shrubs.



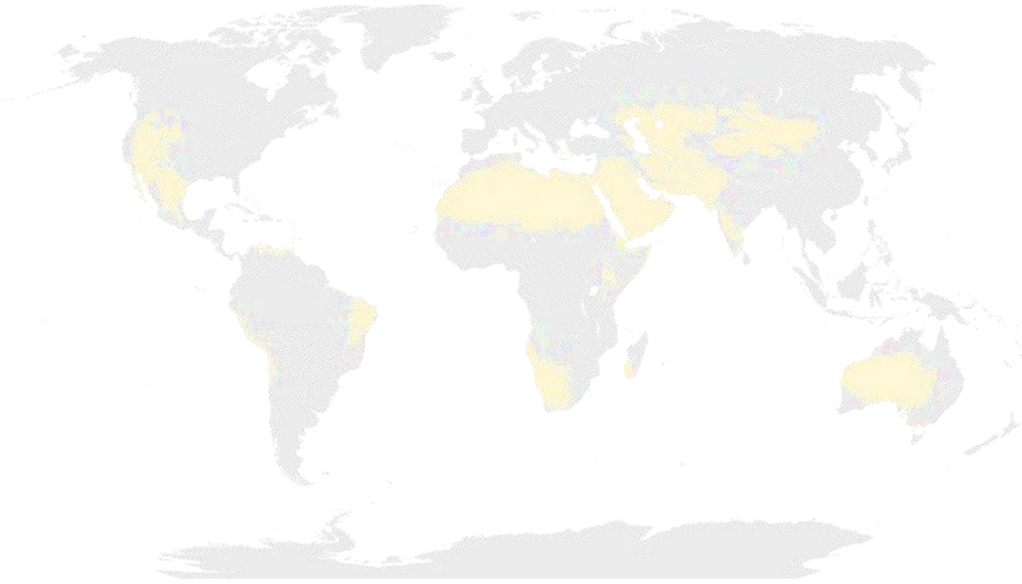
Temperate prairies

This biome is located in the middle-latitudes, where precipitation is moderate. The dominant vegetation there is grass. It is simply called prairie in North America, steppe in South Africa.



Desert

This biome is located where precipitation is very rare. There are deserts on every continent, mainly along the Tropic of Capricorn and the Tropic of Cancer.

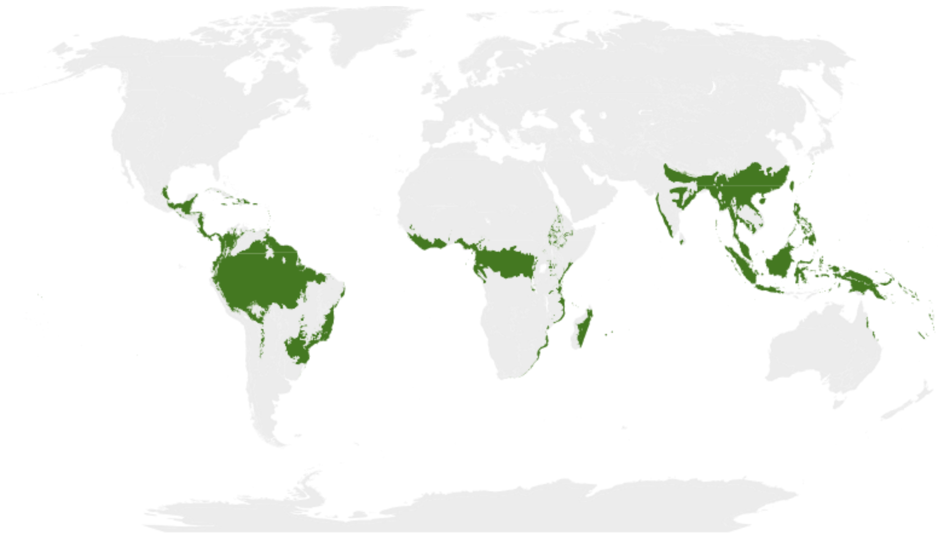


Savanna

It is a prairie with sparse trees. Africa contains the largest savannah in the world, but it is also found in South America, Australia and India.

Tropical rain forest

This biome is found where temperatures are warm during all the year and precipitation is high. The soils are nutrient poor and most trees are evergreen flowering plants.

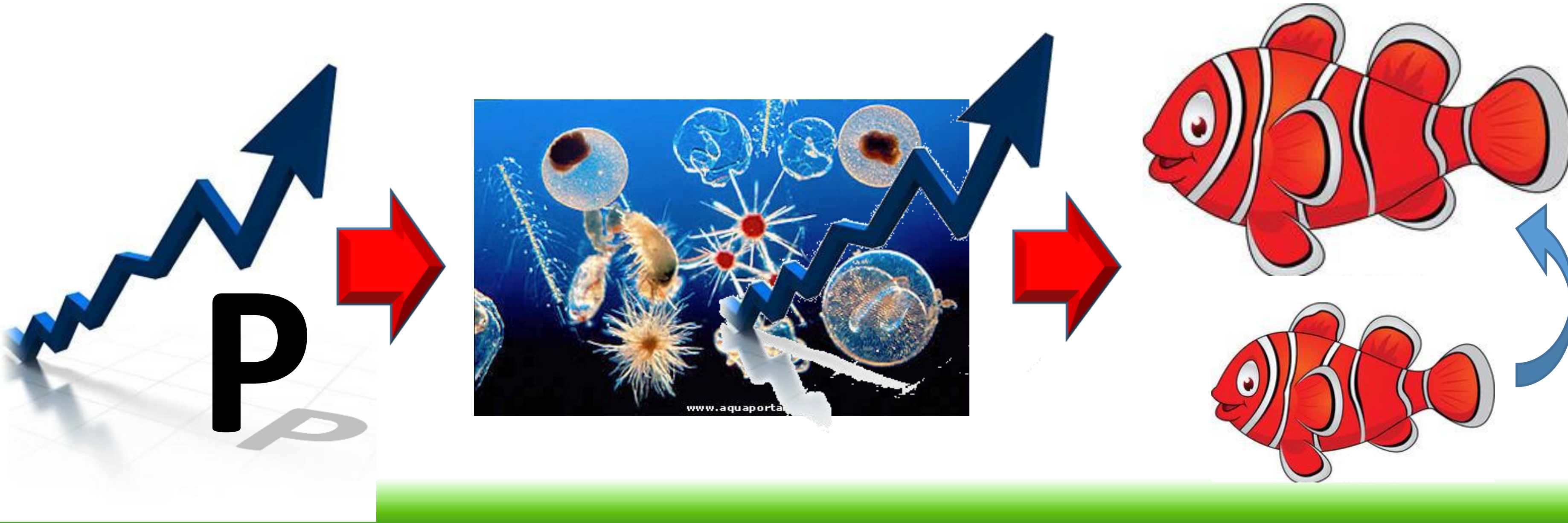


Ecosystem stability

resources availability, regulated by the physicochemical factors of the environment, control **trophic chains** from producers to predators. This is the theory of community control by resources (nutrients), or **bottom-up control** (from down to top).

Example

Ex.: The relationship existing between the phosphate content of the oceans + the quantity of plankton + size of the fish that feed on them.

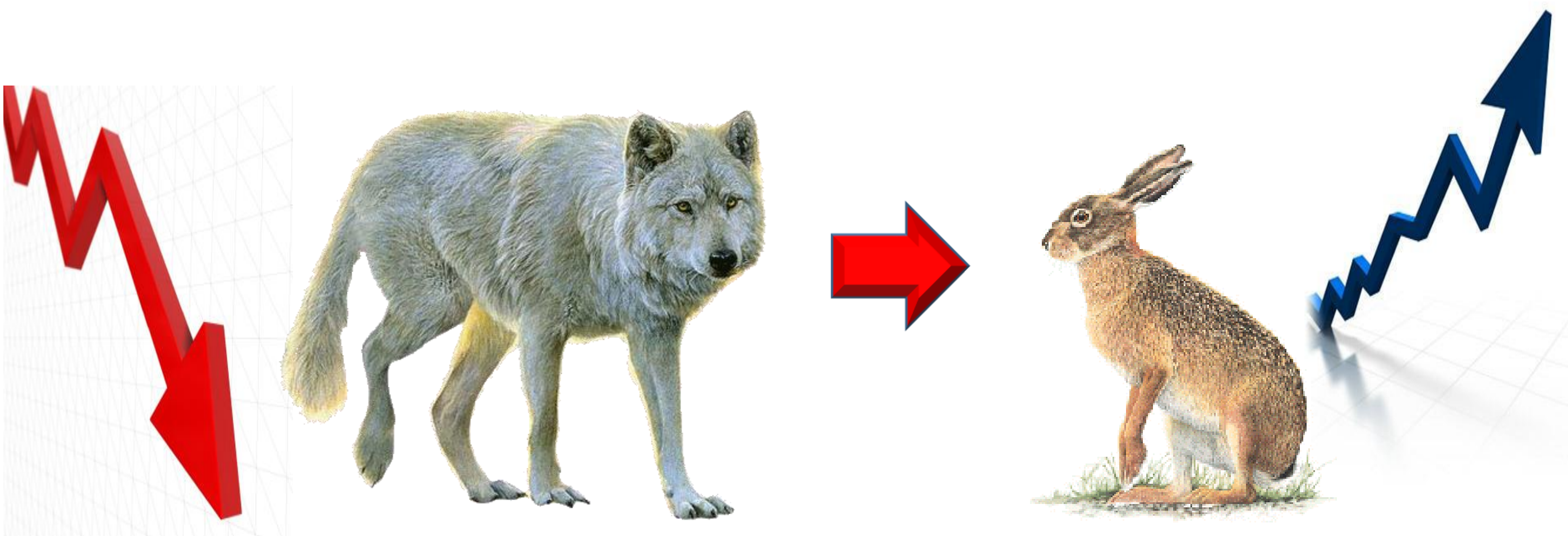


Ecosystem stability

Conversely, the functioning of an ecosystem depends on the predation exerted by higher trophic levels on lower trophic levels. This is **top-down control**.

Example

Regulatory effect of a population of carnivores (wolves) on a population of prey (rabitts).



Ecosystem stability

Both controls occur simultaneously in ecosystems and can be complementary. **Modifications by humans (anthropic actions)** to a trophic level can amplify one or the other of the two controls and lead to **instability of the ecosystem**.

Example

Increased nutrient resources (**amplification of bottom-up control**). Case of organic water pollution or eutrophication.

Example

Decrease in abundance of predator of high level (**amplification of top-down control**). Case of hunting or fishing.

Ecological succession

All the phenomena of colonization of an environment by living beings and changes in the composition of flora and fauna over time.

1 Series

Mean the complete **sequence of an ecological succession**. It is characterized by a rigorous sequence of stages, each comprising a particular biocenosis.

The organisms that settle first are called **pioneer species**, and the biocenosis that succeed each other correspond **to series**. Ecological successions continue for decades or centuries until they reach their ultimate stage of evolution called **climax**.

2 Climax

I’ts a stable association of species that qualitatively and quantitatively characterize the final phase of development of a biocenosis in an ecological succession.

Types of ecological succession

We have too types: **Primary** and **secondary** successions.

1 Primary successions

Correspond to the settlement of living beings in an environment which has **never been populated**.

2 Secondary successions

Appear in an environment that has **already been populated** but whose living beings have been eliminated by climatic changes (glaciations, natural fires), geological changes (erosion) or by human intervention.

Types of ecological succession

We also distinguish **autogenic (progressive)** successions from **allogenic (regressive)** successions.

1 Autogenic successions

Come from a biotic process occurring **within the ecosystem** (competition, predation, parasitism, etc.).

2 Allogenic successions

result from the influence of disturbing factors of **origin external** to the ecosystem (action of disturbing factors: fire, wind, drought, anthropic, etc.).

Causes of ecosystem evolution

The causes of ecosystem evolution can be summarized in 3 different aspects (**action**, **reaction**, **and coaction**)

Action

Influence exerted by the biotope on the biocenosis with the induction of adaptation phenomena (morphological, physiological, ethological) and regulation of population abundances (maintenance, elimination).

reaction

Influence exerted by living beings on the biotope with destructive, modifying manifestations.

Coaction

Influence of organisms on each other (biotic relationships).

Causes of ecosystem evolution

The causes of ecosystem evolution are grouped into 4 main groups:

1. Climatic factors (change over geological and current eras)
2. Geological and edaphic factors (erosion, sedimentation, volcanism, etc.)
3. Biological factors (competition, parasitism, predation, etc.)
4. Anthropogenic factors (pollution, fires, deforestation, introduction of species, etc.)

General characteristics of successions

1. Ecosystems closer to the climax stage are more organized, more complex than ecosystems closer to the pioneer stage.

2. Biomass increases as ecosystems closing to climax stage. It then becomes constant as productivity tends towards zero.

3. Species diversity increases along gradual successions

4. Interspecific relationships evolve with succession, symbiosis and competition become more frequent.

5. Ecological niches become increasingly limited and specialized as climax approaches. Biological cycles become longer and more complicated

Pioneer species are often opportunistic having adapted ***r-type*** strategies (species with high biotic potential, rapid growth, low longevity, populations that renew quickly and are subject to strong fluctuations). Climax species are species that have chosen ***k-type*** strategies (using most of their energy in growth and maintenance).

Adaptive strategy

Strategy concept

An adaptive strategy is a characteristic specific to the type of adaptation of a Population or a living community to particular environmental conditions.

We distinguish those of ***type-r***, specific to populations of species living in **juvenile communities(pionear biocenoses)**, at the beginning of ecological succession, on the other hand, those of ***type-K*** concerning populations of species specific to **climax bioecenoses**.

Strategy concept

Strategy r	Strategy K
early maturity.	late maturity
short adult life	long adult life
high fertility	Low fertility
varying population density	Constant population density.

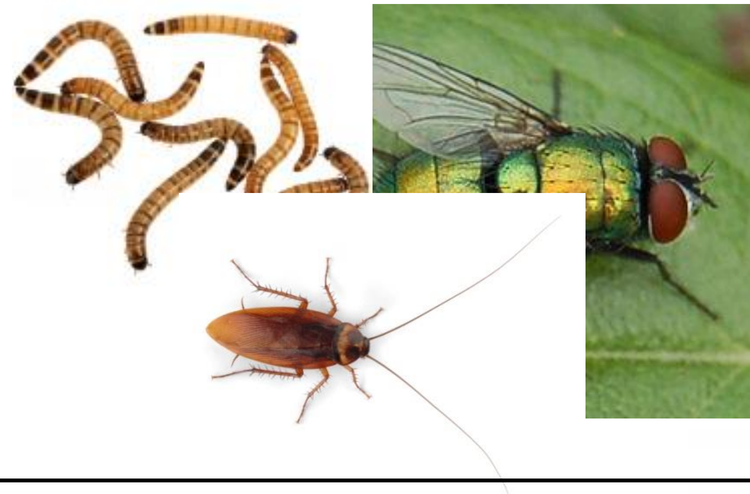
Species with *r strategy* are more adapted to *unstable environments..*

K-strategy species are more adapted to *stable environments.*

Strategy concept

Strategy r

Most insects follow the ***strategy r***; their population densities are extremely variable.



Example

Strategy K

Most large mammals follow the ***strategy K***; their population densities vary more slowly.

Characteristics of r-and K-species

	r-species (opportunist species)	*K-species (equilibrium species)*
Reproduction	Reproduce rapidly (high fecundity, short generation time); therefore high value of ***r*** (the intrinsic rate of increase)	Reproduce slowly (low fecundity, long generation time); therefore low value of *r*
Density vs Reproduction	Reproduction rate not sensitive to population density	Reproduction rate sensitive to population density, rising rapidly if density falls
Offspring #	Investment of energy and materials spread over many offspring	Investment of energy and materials concentrated on a few off-spring, with parental care in animals
Carrying capacity	Population size may temporarily exceed K (carrying capacity of the environment)	Population size stays close to equilibrium level determined by **K**
Spatial dispersal	Disperse widely and in large numbers; with animals, migration may occur every generation	Disperse slowly

Life energy into reproduction	Reproduction is relatively expensive in terms of energy and materials	Reproduction is relatively inexpensive in terms of energy and materials; more energy and materials devoted to non-reproductive (vegetative) growth
Physical size	Small individual size/weight	Large individual size; woody stems and large roots if plants
Life span	Individuals short-lived	Individuals long-lived
Harsh conditions	Can occupy open ground and occupy harsh conditions	Not well adapted to growing in open sites and harsh conditions. Require specialised condtions.
Habitat	Habitats short-lived (e.g. ripe fruit for *Drosophila* larva)	Habitats stable and long-lived (e.g. forest for monkeys)
Competition	Poor competitors (competitive ability not required)	Good competitors

Competition	Poor competitors (competitive ability not required)	Good competitors
Adaptability	More adaptable to changes in environment (less specialized)	Less resistant to changes in environmental conditions (highly specialized for stable habitat)
Defence	Tend to have poor defensive strategies	Good defence mechanisms
Domination	Do not become dominant over time.	May become dominant over time.